

The anomalous ant-attended mealybugs (Homoptera : Pseudococcidae) of south-east Asia

D. J. Williams

Commonwealth Institute of Entomology, c/o British Museum (Natural History), Cromwell Road,
London SW7 5BD

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Synopsis

The morphology, habits and taxonomy of 12 unusual myrmecophilous mealybugs from south-east Asia are discussed. Unusual characters of some of the species are long antennae, an anal ring without pores, a dense covering of minute setae on the dorsum, long anal lobe setae and large protruding ostioles. The ostioles are unlike any others in the Pseudococcidae and are compared with the siphunculi of aphids. *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* are aerial genera and are assigned to the subfamily Pseudococcinae. These four genera have many characters in common and a new tribe Allomyrmococcini is erected for them. Two new species of *Malaicoccus* and one new species of *Paramyrmococcus* are described. *Eumyrmococcus* and *Xenococcus* are subterranean and are placed in the subfamily Rhizoecinae.

Introduction

Mealybugs are easy to recognize in life by an elongate-oval body usually covered with mealy or cottony white wax. This wax often extends around the sides to form a series of short filaments but a pair of much longer filaments may be present at the posterior end of the body. Most species have legs which rarely protrude beyond the lateral margins and movement is usually slow. Oviparous females become sedentary and may secrete a noticeable white cottony ovisac.

In common with all female scale insects, species can be identified only from microscope slide mounts, by the arrangements of body pores and setae. Mealybugs are separated from related groups in possessing at least one of the major characters, cerarii, ostioles, circulus, trilocular pores and tubular ducts which are not cupped at the interior end.

As in all Homoptera, scale insects suck the sap of plants with long stylets and, so far as is known, all mealybug excretion is in the form of honeydew. This substance is excreted in all the families of Coccoidea except the Diaspididae, Conchaspidae, Halimococcidae and certain groups at present assigned to the family Asterolecaniidae. When palatable, honeydew forms an important part of ants' diet and a strong association has been built up between some species of ants and certain Homoptera. The literature discussing this association is extensive and in recent years Nixon (1951), Way (1963) and Wilson (1971) have discussed the subject at some length. Way has defined mutualism as any association beneficial to both the ant and the other insect. Myrmecophilous insects (according to Way) are those which benefit from ants and are more or less adapted to live with them but the relationship need not be obligatory or mutually beneficial.

The majority of myrmecophilous mealybug species having a mutual association with ants are those which a coccidologist would regard as normal and without visible signs of special adaptation. In south-east Asia some myrmecophilous mealybugs have developed most unusual characters and habits and it is the purpose here to describe and discuss this group. At present the group comprises the genera *Allomyrmococcus* Takahashi, *Eumyrmococcus* Silvestri, *Hippeococcus* Reyne, *Malaicoccus* Takahashi, *Paramyrmococcus* Takahashi and *Xenococcus* Silvestri.

Habit

Silvestri (1924) described the first of these mealybugs under the name *Xenococcus annandalei*. It is an elongate-oval species but the abdomen tapers abruptly at the posterior end, and the long antennae are strongly geniculate with a special articulatory mechanism between the first and second segments. One of the most noticeable characters is the dense covering of minute setae on the dorsum which at the time of description had not been seen in mealybugs before. This is a subterranean species found in the nests of the ant *Acropyga acutiventris* Roger. Silvestri described the habit as living on the rootlets of *Ficus* sp. When the soil is damp and warm both ants and mealybugs remain just below the surface under stones but in cold, dry weather they retire deep into the ground. The ants carry away mealybugs in their mandibles when the nest is disturbed and when ants leave the nest, each female carries a female mealybug in her mandibles to new nests elsewhere.

Later Silvestri (1926) described *Eumyrmococcus smithii* from Macao and Shanghai as living under stones with the ant *Acropyga* (*Rhizomyrma*) *sauteri* Forel. Recorded later in Taiwan with the same ant, Takahashi (1934) mentioned that females and workers carry the mealybugs in the mandibles. This species is also densely covered with minute setae and the abdomen is abruptly narrowed but the antennae are short.

Above ground in Thailand were found *Allomyrmococcus acariformis* and *Paramyrmococcus chiengraiensis* described by Takahashi (1941). Both were covered with dense clusters of the ant *Dolichoderus* sp. [= *Hypoclinea*]. *Malaicoccus riouwensis* described by Takahashi (1950) from the Riouw Is (now known as Riau Is) and *M. formicarii* described by Takahashi (1951) from Malaya were both attended by large numbers of *Polyrhachis* sp. This ant carried *M. formicarii* in its mandibles at the constricted part of the thorax. A new species described here as *M. moundi* is also carried at the head or prothorax by the ant *Hypoclinea* sp. (Fig. 1B). Specimens of the mealybug examined in alcohol were firmly grasped in the ants' mandibles which had to be prised apart to release the mealybugs.

Species of *Hippeococcus* described by Reyne (1954) have an even more unusual habit. These species are also aerial, feeding on stems and suckers of various plants, and are covered with ants of the genus *Dolichoderus* (= *Hypoclinea*). Mealybugs of *H. rappardi* Reyne are gleaming without any trace of wax and are very agile. When the ants are disturbed the mealybugs cling to the body, sitting crosswise on the ants' back (Fig. 1A). Immature *H. wegneri* Reyne feeding on young shoots and fruit of *Diospyros kaki* cling to the thorax and other parts of the ant's body. A *Hypoclinea*

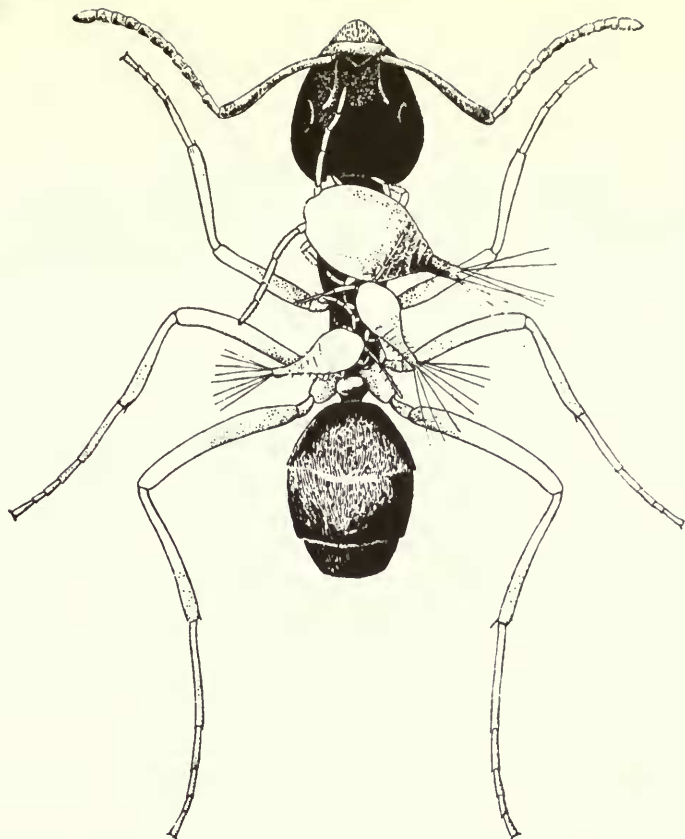
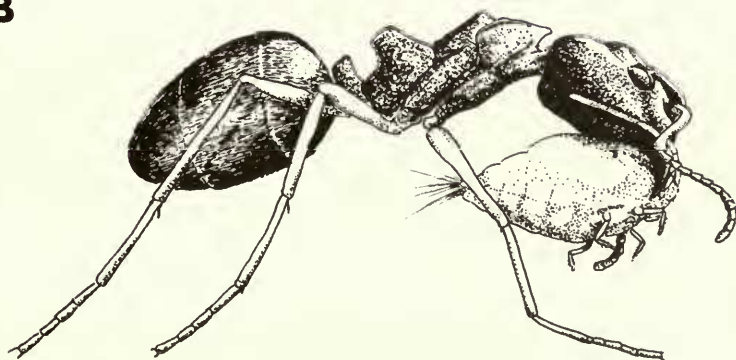
A**B**

Fig. 1 (A) Ant, *Hypoclinea* sp., carrying *Hippeococcus* sp. on its back. Redrawn from Reyne (1954).
(B) Ant, *Hypoclinea* sp., carrying *Malaicoccus khooi* in its mandibles. Drawn specially for this work by Mrs Linda Huddleston of the British Museum (Natural History).

nest is also aerial and sometimes contains numerous mealybugs which, according to Reyne, cling to the ants' bodies when the nest is opened. Ants also drag along swollen adult females and sometimes carry mealybugs in their mandibles. Reyne mentioned that ants were often seen drumming incessantly on a certain spot on the mealybugs and although honeydew was produced as a clear drop at the tip of the abdomen, the ants showed little interest in it. When *H. wegneri*, living on *Cyclanthera explodens*, was disturbed, the ant colony assumed an alarm position and the ants evacuated the mealybugs by first tapping each mealybug with the antennae and then carrying the mealybugs on their backs. Larger mealybugs were often given preference and after the disturbance the ants returned to unload the mealybugs.

These observations reveal an unusual and possibly old association between ant and mealybug but leave many questions unanswered. Broadbent (1951) stated that aphids excreted honeydew only when feeding and if mealybugs excrete in the same manner, it is strange that ants were never seen to take honeydew from *Hippeococcus* on the stems. There were no observations as to whether the mealybugs were feeding inside the nests or whether ants were soliciting them. It is difficult to imagine such a close relationship without ants receiving honeydew at some time and it must be assumed that they take it. No sooty moulds were observed growing on any honeydew falling on plant material. Way (1954) reported that when the ant *Oecophylla longinoda* (Latreille) in Zanzibar was removed from the Coccid *Saissetia zanzibarensis* Williams there was a noticeable fall in the Coccid population because of increased parasitism and suffocation from the Coccid's own honeydew. Das (1959) reported similar suffocation of *Coccus hesperidum* L. on tea in Assam when ants were excluded. The honeydew apparently oozes slowly rather than being ejected for some distance as in *Pulvinaria ribesiae* (Signoret) reported by Newstead (1903). Furthermore, during periods of heavy rainfall in Zanzibar, *O. longinoda* workers were often unable to remain in attendance on the Coccid and the honeydew was washed on to the surrounding leaves. *Hippeococcus* and *Malaicoccus* live in areas where heavy rain beats on ant and mealybug for long periods without any lessening of ant activity. Bünzli (1935) reported that the ant *Rhizomyrma paramariensis* in Surinam carried *Rhizoecus* [= *Neorhizoecus*] *coffea* Laing and *Geococcus coffea* Green from wetter to drier areas in underground nests. Way (1954) noted that *Oecophylla longinoda* kept *Saissetia zanzibarensis* numbers at a level which satisfied the honeydew requirements. Flanders (1957), discussing the obligate myrmecophilous mealybug *Chavesia* sp. and the obligate coccidophile *Rhizomyrma fuhrmanni* Forel, stated that the mealybug can feed only on roots exposed by the ant. Furthermore, the worker ant regulates the number of mealybugs feeding at any one time by placing about 70 per cent of the total mealybug population in reserve in a non-feeding position off the roots. How ants remove mealybugs from stems without damaging the stylets has never been observed. In *Hippeococcus* there are apparently numbers of mealybugs on the stems and even greater numbers in ants' nests and one can only speculate that this is a form of regulation by the ant. *Hypoclinea* is not an obligate coccidophile and the question remains whether *Hippeococcus* and the related *Malaicoccus*, *Allomyrmococcus* and *Paramyrmococcus* are obligate myrmecophiles. The answers probably lie in the unusual characters of these mealybugs and these are discussed in the section on morphology.

Distribution

Although Silvestri described *Xenococcus annandalei* from Lake Chilka near the West Bengal border, it has been discovered since in Mysore, southern India and Penang in West Malaysia, northern Vietnam and Hong Kong, always associated with the ant *Acropyga acutiventris* Roger. *Eumyrmococcus smithii* is known from Macao and Shanghai in China and in Japan and Taiwan associated with the ant *Acropyga sauteri*. These two mealybugs are subterranean and probably feed on a wide variety of roots.

Among the aerial species, *Hippeococcus* is known from Java only. *Malaicoccus* is known from Malaya and the Riouw Is in Indonesia but based on the identity of immature stages in this work, a third stage of an apparently new species was mixed with *Allomyrmococcus acariformis* when Takahashi described it from Thailand. *Paramyrmococcus* is discussed here from Thailand and

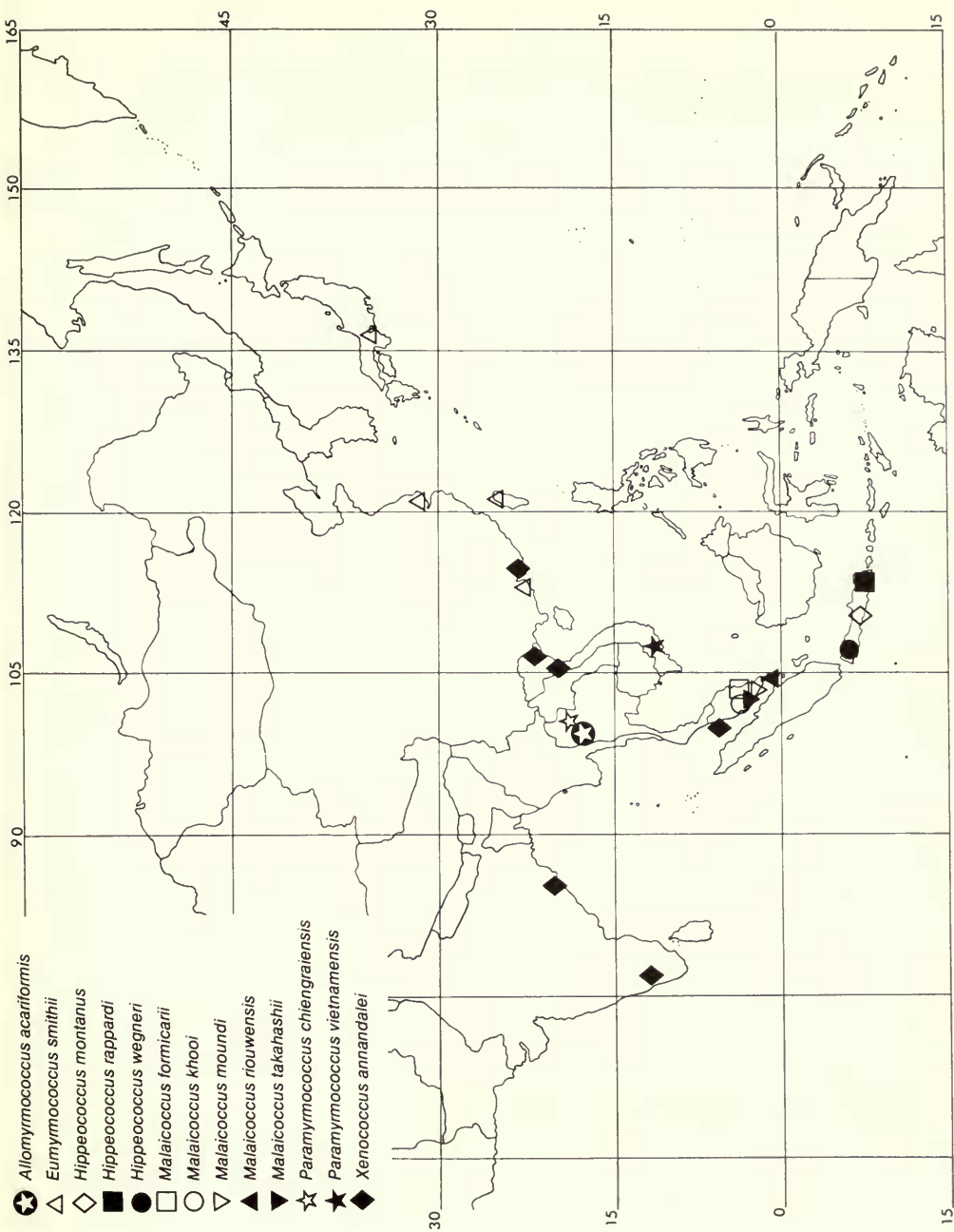


Fig. 2 Distribution of myrmecophilous mealybugs in south-east Asia.

Vietnam. These aerial species seem to be attended only by ants of the genera *Hypoclinea* and *Polyrhachis* which are widespread in south-east Asia. The mealybugs will probably have a distribution throughout the area wherever the ants are present. Since this paper went to press the writer has received a new species of *Malaicoccus* attended by *Hypoclinea* sp. from Sarawak near the border with Sabah.

Morphology

Body

In life the body shape tends to be clavate with the head and thorax dilated and with the abdomen narrowing abruptly at about the third segment. Only in *Malaicoccus* is the abdomen broadly rounded. The body of *Xenococcus* is widest at about the first abdominal segment but the body still has a clavate appearance by the enormous basal segments to the antennae. *Paramyrmococcus* is more turbinate. In South America *Chavesia* has a similar body shape to that of *Eumyrmococcus*. *Chavesia* seems to have developed along similar lines to the genera in south-east Asia and there is strong evidence that *Xenococcus* and *Eumyrmococcus* are closely related to *Chavesia* but that *Allomyrmococcus*, *Paramyrmococcus*, *Malaicoccus* and *Hippeococcus* form a separate group. Coccidologists become used to studying flattened insects on slides, discussing only dorsal and ventral surfaces and forgetting that species have lateral sides. In all the genera from south-east Asia and South America the abdomen curves upwards at the posterior end, as shown by Silvestri (1924; 1926) and by Balachowsky (1957). It is not clear what advantage this gives to the mealybug or the ant. When an ant strokes a mealybug the abruptly narrowed abdomen may resemble an ant petiole and so the mealybug may be more readily accepted. Ants seem to carry these mealybugs near the head and prothorax whereas ants carry mealybugs of more normal shape at about the first abdominal segment. As Bünzli (1935) has remarked, the mandible marks may disappear but sometimes they may persist. *Malaicoccus* has developed heavy sclerotization on the head at the point where they are carried.

Legs

The legs of all species are well developed and reach their greatest length in *Allomyrmococcus* when they are longer than the body. Reyne (1954) has mentioned that *Hippeococcus* moves quickly yet Strickland (1950) stated that in West Africa the mealybugs associated with ants have shorter legs than the active longer legged species that are not associated with ants. The leg setae are well developed on each species and sometimes they are abundant. The claw gives some clue that these mealybugs belong to two distinct groups. In *Xenococcus* and *Eumyrmococcus* the claw is long and slender with a pair of short setose digitules at the base but in the other four genera the claw is stout with a pair of large flattened digitules which are usually twice as long as the claw. Reyne (1954) has suggested that *Hippeococcus* uses the digitules to cling to the ants' bodies and this seems a reasonable deduction. It should be remembered that these large flattened digitules are present in *Allomyrmococcus*, *Paramyrmococcus* and *Malaicoccus* also but these mealybugs apparently do not cling to ants' bodies. The tarsus of each species has a single campaniform sensillum at the outer proximal end, a structure discussed recently by Koteja (1974b).

Antennae

Eumyrmococcus has short 2-segmented antennae but in *Xenococcus* the antennae are 4-segmented of a most unusual type. These are long and strongly geniculate with a large basal segment. The articulation between the first and second segments is so well developed that the antennae can bend from a forward position to one lying along the back of the mealybug. Helping in this movement are small teeth on the outer proximal corner of the second segment which fit into grooves on the outer distal corner of the first segment. Long pointed setae are present on all the segments and on the third and fourth segments some setae are as long as the segments. As *Xenococcus* lives underground it is probably advantageous for the mealybug to streamline its body by folding

the antennae along the back but in other circumstances the antennae may be used for recognizing an ant.

The antennae of the other four genera are 6-segmented and are unlike those of any other mealybugs. In each species and in all stages, the second segment is short and does not articulate with the third segment. In the first stage larvae, long setae form whorls mainly at the distal ends of the segments but in *Paramyrmococcus vietnamensis* the fifth and sixth segments have numerous short setae also. Short setae are present on all second instars and they become more numerous and longer on each successive stage so that the adult antennae are densely covered. The antennae in most adult females of this group are about as long as the body. It is difficult to understand why these insects have such long and well-developed antennae. It is usual for an ant to feel or stroke a mealybug before either attending one or carrying one away. Mealybugs of *Hippeococcus* and possibly those of related genera may equally seek out or recognize an ant with their long antennae.

Setae

One of the striking characters of nearly all these mealybugs and the South American genus *Chavesia* is the dense covering of minute setae over the entire body or at least over the dorsum. In many species the setae are short and are so numerous that the distance between the setal bases is much shorter than the length of a single seta. These mealybugs are without the usual protection of mealy or flocculent wax and the numerous setae may act as an alternative protective covering. By trapping air between the setae, the body surface of underground species would be protected from excessive moisture. The aerial species are exposed to heavy rains for long periods and the dense covering of setae may have a waterproofing effect.

Some species do not have such dense coverings. Adult *Hippeococcus* have, in addition to minute pointed setae, small blunt setae of uncertain function. Longer clavate and fleshy setae, which in *H. rappardi* are present in the first stage only, persist in all stages in *H. wegneri*. In many of the immature stages of *Malaicoccus* there are minute setae in varying numbers, each with the seta shorter than the diameter of the setal base. Immature *Paramyrmococcus* have body setae which are short, cylindrical and blunt but these are replaced by numerous short pointed setae in the adult. A few setae which are flat and variously shaped are present on the head and thorax of *Xenococcus*. There is little difference, apart from abundance, in the arrangement of the setae in the stages of *Allomyrmococcus* but immature stages have extra long setae on parts of the body. Adult mealybugs, therefore, usually have some characters such as the addition of special body setae or the loss of long setae, which distinguish them from the immature stages. Ants may be able to recognize these differences by quickly stroking the mealybug's body.

Anal areas

This section includes the anal ring, anal lobes, anal lobe setae and any other structures at the apex of the abdomen. The anal ring is usually sclerotized with 6 setae of various lengths and always without pores except for a few minute pore-like openings in *Malaicoccus*. In the more usual mealybugs, of which *Pseudococcus obscurus* Essig is an example, a short wax tube is secreted from pores around the anal ring. Honeydew droplets are, therefore, excreted a short distance from the body surface. A colony of *P. obscurus* on a potato tuber at times ejected honeydew for a distance of 2–4 cm. This honeydew is clear and sticks to the surrounding foliage, but each droplet of honeydew of the cochineal insect *Dactylopius coccus* Costa is coated with fine wax and falls directly to the ground without sticking to the plant. Broadbent (1951) has mentioned that the aphid *Hayhurstia atriplicis* (L.) excreted globules coated with wax from contact with the wax covering of the aphid. There is always the possibility that wax coating may affect the palatability to ants. No observations have yet been made on the honeydew of the myrmecophilous mealybugs.

Reyne (1954) has stated that *Hippeococcus rappardi* had usually a clear drop of liquid between widely diverging silvery hairs, which are presumably the anal hairs. In *Chavesia*, Beardsley (1970) has described the anal lobes as protuberant and sclerotized on the ventral surface. The anal ring is in a membranous depression on the dorsal surface of the lobes. These lobes also contain

numerous setae and the whole structure forms what Beardsley has called a honeydew basket. A similar structure is present in *Allomyrmococcus* and *Malaicoccus* but the anal ring may be terminal or situated a short distance from the apex. In *Hippeococcus* and *Xenococcus* the anal ring lies at the apex of the dorsum which projects beyond the ventral anal lobes. Wherever the anal ring is placed it is within easy access for the ant and in the absence of pores it seems likely that honeydew remains at the apex of the abdomen until the ant removes it. Broadbent (1951) has described how the aphid *Hyalopterus pruni* (Geoffroy) kicks away globules with the hind legs. Normally the legs of mealybugs are too short to reach the anus but in the absence of ants most of the myrmecophilous mealybugs in this discussion could remove globules with their legs if necessary but this has not been observed.

Long anal lobe setae are present in all genera except *Paramyrmococcus*. Sometimes they are numerous and are longer than the body. Their function is uncertain and their absence in *Paramyrmococcus* does not seem to affect the myrmecophilous habit.

As previously stated, honeydew is probably produced only when the mealybugs are feeding. Furthermore excretion rates may be increased by ants attending mealybugs and removing honeydew. It is usual for an ant to stimulate the mealybug into giving up a drop of honeydew by palpating the abdomen, but the mechanism of this stimulation is not understood. In the Coccidae, Way (1954) and Smith (1942) have discussed how ants solicit species of *Saissetia* by dragging the tips of the antennae back and forth over the caudal end of the body. *Saissetia* and *Udinia* are two related genera often solicited by ants in the tropics but species of both genera have long primary discal setae on the anal plates which when touched may induce the Coccid to open the plates and excrete some honeydew. By stroking the anal ring setae, ants may induce mealybugs to excrete a droplet.

Body pores

An important feature of the myrmecophilous mealybugs is the almost complete absence of pores and ducts. All species have been described without surface wax, and Reyne (1954) described *Hippeococcus* as having a gleaming body. *Eumyrmococcus* and *Xenococcus* are completely without body wax pores and in all the other genera the only pores present in the female stages are trilocular and a few simple pores except in some species of *Malaicoccus* which have a few oral collar ducts in the mid-thorax and anterior abdominal segments. In most species the trilocular pores are quite sparse but in *Hippeococcus* and certain *Malaicoccus* species they are more numerous. It is only the second stage male which has the more usual pores associated with mealybugs. In *H. wegneri* and *M. moundsi* the second stage males have multilocular disc pores and oral collar tubular ducts and it is assumed that these secrete the waxy covering for the pupal stage. Nixon (1951) has given a few examples of ants removing wax coverings of mealybugs. For instance, Le Pelley (1943) noted that ants removed wax completely from certain areas of the body of *Pseudococcus* [= *Planococcus*] *lilacinus* (Cockerell) in the Philippines. It is not clear how male mealybug pupae could retain wax coverings in the presence of attending ants. Nevertheless, the gleaming and waxless condition of myrmecophilous mealybugs is probably the result of specialization in the continual presence of ants. Recently Delage-Darchen et al. (1972) have noted an unusual association between Diaspidid scale insects and ants. The scale insects live in tunnels in woody stems and are attended by ants in so far as ants remove the scale coverings. One species of these scale insects is completely without dorsal ducts so that no scale could be secreted anyway. Similar observations with scale insects have also been made by Prins et al. (1975). Although ants may remove wax for food it is also possible that in time species that would normally secrete a wax covering evolve without even any means of producing one. It is difficult to understand how ants benefit from species not producing honeydew.

Labium

The labium of Pseudococcidae is conical and 3-segmented and its morphology has been studied by Koteja (1974a) whose terminology is used here. The basal segment is small with a pair of rounded sclerites, often fused medially with the medial segment, and contains 2 pairs of short

setae and one longer pair. On the medial segment there is a basic number of 1 pair of setae. The apical segment has 2 or 3 pairs of posterior setae on the posterior or under surface, a pair of short apical setae, 4 pairs of subapical setae, one pair of lateral setae and 2 pairs of anterior setae situated near the base. In many species there are supernumerary setae anterior to the lateral setae.

Koteja recognized the four subfamilies Trabutininae, Pseudococcinae, Rhizoecinae and Sphaerococcinae. The Trabutininae is separated from the others, using the character of the labium only, in possessing 3 pairs of posterior setae. All the species studied in this work have 2 pairs of posterior setae and the species are separated from the Sphaerococcinae in having a well-developed basal segment not fused totally with the medial segment. The labium of Rhizoecinae, according to Koteja, differs from that of the Pseudococcinae in being small and narrow with the third subapical setae distinctly stouter than the others and with the lateral setae about twice as long as the other labial setae. Williams (1969) has already placed *Eumyrmococcus* in the Rhizoecinae on other grounds but the labium of this genus has a width-length ratio of 1 : 2, there are 14 pairs of setae and the subapical setae become progressively longer towards the base. *Xenococcus* has a labial width-length ratio of 1 : 1.87 when flattened on the slide and 1 : 2.27 when not flattened. The number of setae varies from 12 to 13 and the subapical setae are remarkable in extending more than half way to the base of the apical segment. As in *Eumyrmococcus* these subapical setae become progressively longer towards the base of the segment. For reasons to be given later under classification, *Xenococcus* should be assigned also to the Rhizoecinae.

In the genera *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* the width-length ratio of the labium varies considerably from 1 : 1.4 in *P. chiengraiensis* to 1 : 1.92 in *Malaicoccus khooi*. Despite this range in size there is reason to believe that these genera with *Allomyrmococcus* belong to the Pseudococcinae. In *Allomyrmococcus* and *Malaicoccus* the total number of setae varies from 20 to 32 pairs in the adult female but in the first and second stages they become reduced to the basic number of 14 pairs.

Circulus

The circulus, when present, is a round or oval sclerotized area, surrounded by a rim, usually lying on venter between the fourth and fifth abdominal segments. Occasionally it may lie within the borders of the fourth segment and some species may have several circuli on different segments. In the Rhizoecinae the circulus is usually small and round but heavily sclerotized, conical and often with an irregular surface. Pesson (1939a) and Lloyd & Martini (1957) have shown that adult females of the genera *Pseudococcus* or *Phenacoccus* use the circulus as an adhesive organ when viewed in profile against a glass surface. The circulus is exerted and then adpressed to the surface allowing the insect to make exploratory leg movements, the body actually pivoting at the circulus. This use seems to be restricted to the adult female because Lloyd & Martini observed that the three nymphal instars were able to ascend or descend with ease by leg actions presumably with the help of the claw digitules.

No similar research has been done on the circulus of the Rhizoecinae but Silvestri (1924), working on alcohol material of *Xenococcus annandalei*, suggested that the circulus of this species secreted some kind of liquid possibly attractive to ants. Whatever its function it does seem that the circulus of the Rhizoecinae has been derived from those of the other groups of the Pseudococcidae.

Ostioles

Among the Coccoidea the Pseudococcidae are unique in usually possessing 2 pairs of transverse slit-like organs on the dorsal surface, commonly named ostioles. In *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* the ostioles reach an unusual development and this seems an appropriate place to discuss their structure and to compare them with siphunculi or cornicles in aphids.

Occasionally some species of such genera as *Rhodania* Goux and *Ehrhornia* Ferris are without ostioles but they may be present in some of the immature stages where they are limited to the posterior pair only. In adult females of *Antonina*, ostioles may be present as a poorly developed

posterior pair only. The absence or reduction of ostioles is correlated with the amount of external wax secreted from the pores, the term wax being used here in its general sense. Usually those species producing large amounts of dorsal wax or those which become almost enclosed in a felted ovisac, as in *Antonina*, have reduced ostioles.

According to Ferris & Murdock (1936) the anterior pair belong to the pronotum and the posterior pair to the sixth abdominal segment. Pesson (1939b), however, after an overall study of the musculature, concluded that the anterior pair are placed slightly forward to the anterior edge of the prothorax and the posterior pair lie between the fifth and sixth abdominal segments.

Viewed from above each ostiole is composed of two membranous lips which often contain numerous setae and trilocular pores. The inner edges of the lips are usually sclerotized and sometimes these inner edges are the only parts visible.

Sulc (1909) observed in *Phenacoccus farinosus* (de Geer) that blood corpuscles oozed from the ostioles after pressure was applied to the body. He also observed some muscles parallel to and perpendicular to the lips of the ostioles.

In histological studies Ferris & Murdock (1936) found no muscle attachments on these structures and concluded that they led directly into the haemocoel. When the insect was stimulated by an application of violence, a globule of liquid appeared which quickly hardened on exposure to air. The globule, according to Ferris & Murdock, was merely a portion of the body fluids.

In more detailed histological studies, Pesson (1939b) found that in a transverse section, the edges of the slit are continued into the body cavity as a chitinized depression, the median part of which forms an orifice leading directly to the haemocoel. From the lateral inner ends of the depression in each anterior ostiole are inserted two muscles, the anterior or inner muscle inserting itself obliquely to the inner edge of and lateral to the clypeus, and the posterior or outer muscle attached a little anterior to the first leg. There are also two similar muscles in each posterior ostiole which are attached ventrally. If an ostiole is regarded as a valve then normally it should prevent blood loss when at rest but after an application of some body violence near an ostiole the muscles contract and open the lips slightly to emit a droplet of blood or other contents of the haemocoel. This emission, according to Pesson, is nothing more than reflex-bleeding or auto-haemorrhage.

Sulc (1909) noted that the expelled wax, on hardening in contact with air, could have a protecting roll by coating the oral parts of an attacker. Pesson never witnessed this in *Pseudococcus adonidum* (L.) [= *P. longispinus* (Targioni-Tozzetti)] and indicated that the liquid expelled is from the free wax occurring in the blood as corpuscles. After repeated excitation of the surrounding cuticle young wax-producing cells may be emitted. Wheeler (1921), in his studies of the myrmecophyte *Tachigalia* and the attending behaviour of beetles of the genus *Coccidotropus* on *Pseudococcus bromeliae* (Bouché) [= *Dysmicoccus brevipes* (Cockerell)], observed that the beetles were interested only in the honeydew excreted and were never immobilized or impeded by any secretion from the ostioles. He stated that the beetles may be attracted by some fascinating aroma secreted by the mealybug but did not actually state that this was emitted from the ostioles.

After Coccoidea are macerated in potash as a first step in the mounting technique there are often observed certain internal wax globules varying in quantity as to the family. It is in the Pseudococcidae that this internal wax is most strikingly abundant and it is apparently this free wax which is expelled through the ostioles.

The posterior ostioles have often been homologized with the cornicles or siphunculi of aphids. Little work has been done so far on ostioles but in recent years work on siphunculi has been extensive. A résumé of recent work on siphunculi in aphids is given here and it is hoped this may stimulate further work on ostioles.

It was shown by Hottes (1928) that cornicles are situated on the dorsolateral surfaces of the sixth abdominal segment. In their most conspicuous form they are cylindrical and longer than wide. Usually the longer cornicles are movable but at the tip of all cornicles there is a slit-like opening which may be opened or closed by a valve moved by a muscle attached near the median-free portion of the valve. The valve is attached at the apex by a flexible hinge. Hottes further indicated that, although cornicles may be movable, the possibility that droplets can be aimed is practically nil. The function of the cornicles, according to Hottes, was not a defence mechanism

but was part of the metabolic processes carried out by the aphid and that the cornicles have an excretory function. Furthermore, the presence or absence of cornicles may be correlated with the presence or absence of wax pores or a lower reproduction rate. Hottes stated that as aphids have often evolved along with their hosts the change in structure of the cornicles may be the result of the nature of the food consumed.

Despite Hottes' rejection of the defence mechanism function of cornicles, Dixon (1958) observed that if the larva of the coccinellid *Adalia decempunctata* (L.) was smaller than the aphid *Microsiphum evansi* (Theobald) and seized an appendage, the aphid could escape by pulling the appendage free. If the coccinellid larva and aphid were about the same size the aphid could escape if the siphunculus nearest the appendage swung over and placed a drop of oily liquid on the coccinellid's head where the drop would spread over the mouthparts and solidify.

Reflex-bleeding discussed by Hottes was confirmed in aphids by Edwards (1966) who stated that when the cornicle valve is opened, the aphid released material from the haemocoel. As no solvent of the internal material was detected by gas chromatography he explained that the fluid is in a stable liquid-crystalline state within the aphid and changes to the solid crystal phase with a seeding nucleus. He further stated that the rapid crystallization on contact with a solid surface, a hair or duct, suggests that the liquid was in a supercooled state and that foreign material provides a seeding nucleus. The melting point of the waxes of three species of aphids ranged from 37.5 °C to 48 °C so that the waxes should crystallize on seeding at normal summer temperatures. Studying the cornicle area of various species of aphids, Wynn & Boudreaux (1972) found that in *Cinara* and *Longistigma* a multicellular sac possessing a wall, formed from a layer of flat cells with compressed nuclei, extends into the cornicle. This sac is surrounded by vacuolated fat cells and a mass of lipid is found in the sac. All the aphids studied possessed a muscle inserting on the cornicle valve and originating on the venter below the cornicle. The authors suggest that this muscle, in addition to opening the valve at the distal end of the cornicle, may also assist in elevating the cornicle. They also suggest that a dorsoventral muscle just anterior to the cornicle appears to be used in association with other dorsoventral muscles in compressing the body contents causing the emission of a droplet. In each case the cornicle communicates with the haemolymph and blood cells including fat cells escape. The colour of the cornicle droplet corresponds with the colour of the aphid and its haemolymph.

In contrast, Lindsay (1969), studying the cornicles of the pea aphid *Acyrtosiphon pisum* (Harris), stated that the term reflex-bleeding as applied to cornicle exudation is inapplicable since, although a small amount of haemolymph may escape, the primary exudate is the cornicle cells. Analysis of these cornicle cells indicates a close similarity to those of the fat-body cells in composition. Lindsay suggested that the fat-body cells and cornicle cells are homologous, the fat body being a precursor of the cornicle cells and that there is a greater tendency of the cornicle cells to crystallize compared with those of the fat-body cells.

Evidence that haemolymph is not extruded through the cornicles was presented by Strong (1967) who stated that lipids were the principal constituents of the hardened cornicle droplets and were composed solely of triglycerides. Histological preparations by Chen & Edwards (1972) showed that the cornicle secretory cells are present inside a sac separated by a thin acellular lamina from the haemolymph. The sac is formed by an invagination of the epidermal basal lamina reflected back from the tip of the cornicle. The enclosed secretory cells are comparable with epidermal gland cells or subepidermal oenocytes. Fluid in the sac differs in composition from the haemolymph and the fluids released through the cornicle are thus not a direct loss of haemolymph but are presumably derived from the haemolymph.

Referring to the triglycerides in the cornicle secretions, Callow et al. (1973) found that the secretions in any one species are the same and that different species of aphids taken from the same host plant have different secretions. The authors found it was easier to obtain droplets from young or small aphids rather than large aphids and they presumed that the larger aphids have less need of a defence mechanism. This is interesting because as already stated ostioles may be present in immature mealybugs and absent in adults although defence mechanisms in mealybugs have not been proved there may be a greater need for ostioles in immatures for different reasons. Analysis by Greenway & Griffiths (1973) of the body triglycerides showed them to contain

the same fatty acid radicles as in the cornicles but in many species there are greater proportions of some triglycerides in the body. When an aphid is overstimulated the composition of the cornicle secretions gradually becomes the same as the body contents.

Speculative suggestions that odours may be emitted by mealybug ostioles have not so far been confirmed but Dahl (1971) reported that odours from crushed aphids repelled other aphids. Kislow & Edwards (1972) found that certain aphids are repelled by the odour from cornicle droplets and squashed specimens of the same species. These authors proposed that when there is a slow release of odour it may cause intraspecific spacing of aphids, prevent the influx of other species or even induce aphids to migrate. The alarm pheromone was identified as trans- β -farnesene or TBF in some aphids by Bowers et al. (1972). Nault et al. (1973) showed that the alarm pheromone is known to be interspecific and that the receptor of this repellent odour is the primary sensorium on segment 6 of the antenna. The existence of multiple alarm pheromones was suggested by Nault & Bowers (1974) who found that *Hydaphis erysimi* (Kaltenbach) does not respond to pure TBF and they suggest that the aphid produces one or more other compounds in addition to TBF to produce alarm activity.

Before referring once more to ostioles in mealybugs it is interesting that Dixon & Stewart (1975) after blocking the openings of siphunculi of the sycamore aphid *Drepanosiphum platanoide*s (Schrank) found that this occlusion had no adverse effect on the number of offspring produced or on the weight of the aphid. Furthermore, aphids with occluded siphunculi do not space out differently from aphids with normal siphunculi and that the aphid takes most avoiding action when the smell of the pheromone is accompanied by vibrations associated with a struggling aphid.

There is obviously a need for much further research on ostioles. Even a cursory glance at the ostioles of *Allomyrmococcus*, *Paramyrmococcus* and *Hippeococcus* shows that they are much more highly developed than in normal mealybugs. The sclerotized lips have their greatest development in any mealybugs known to the author. Although in the illustrations they are located on the edges, this is due to dorsoventral flattening when specimens are prepared on microscope slides but even in specimens preserved in alcohol they are unusually large and conspicuous with the sclerotized lips protruding on the dorsolateral areas of the body. Their most unusual development is found in *Malaicoccus*. In this genus the anterior pair are often located on the ventral surface on slide preparations. Each ostiole appears to have a fixed anterior sclerotized lip but the posterior lip is a large hinged semicircular flap often containing numerous setae. This flap is often seen completely closed but in some specimens it is open and raised at a right-angle.

In the four genera there is in each ostiole a membrane, easily taking up stain, which completely covers the opening of the lips. It is not certain, working only from microscope preparations, whether there is any opening on this membrane. There is in some specimens a hole or slit on the surface but this may be due to tearing during the mounting technique. The membrane may normally be internal and may be exerted as a result of pressure on the body when flattened.

Why these species should possess such complicated ostioles is still uncertain but the mealybugs, as explained earlier, are transported when the ants are disturbed. Although ants are attracted to excretions of honeydew it is doubtful if honeydew has any odour over long distances but any odour from the ostioles would attract ants and thus help them to transport mealybugs back to the preferred host plants. This is conjecture but any work on pheromones must be done in areas where the mealybugs are common. It is easy to bring aphids into the laboratory for study but much more difficult to experiment with the most interesting of mealybugs which inhabit the tropics. If there is an odour from ostioles of these myrmecophilous mealybugs to attract ants, then there is possibly a similar odour emitted, as suggested by Wheeler, from those mealybugs with a less obligatory association with ants. Any research on this odour could lead to an alteration of the relationship between ants and mealybugs and could possibly help in controlling mealybugs. Mutual association with ants in the Palaearctic Region is common in such mealybugs as *Chnaurococcus subterraneus* (Newstead) and *Euripersia europaea* (Newstead), species which may be useful for research, and in the sugar-cane areas mealybugs living in association with ants are common enough to afford the means for easy research. It is doubtful, for instance, whether alarm pheromones are emitted by mealybugs as in aphids but any work on mealybug ostioles that may determine if their function is different from reflex-bleeding usually propounded would be useful.

Classification

Xenococcus and *Eumyrmococcus* seem to belong to the subfamily Rhizoecinae. Williams (1969) placed *Eumyrmococcus* in this group because it possesses long slender claws with setose digitules and 3 pairs of long anal lobe setae. *Xenococcus* has similar long claws and also 2 circuli which are round, sclerotized and slightly conical. The antennae are not typical of the Rhizoecinae but the reduction in the number of segments suggests a relationship. The long slender labium of both genera each have a width-length ratio of 1 : 2 and the assignment of the genera to the Rhizoecinae agrees with research of the group made by Koteja (1974a; 1974c). Beardsley (1970) tentatively placed the genus *Chavesia* in the Rhizoecinae and this is probably correct. Some of these species have 4-segmented antennae but of a different shape to those of *Xenococcus*. The labium of *Chavesia* has a width-length ratio varying from 1 : 1.33 to 1 : 2.00 but Beardsley has described it as being 2-segmented only so that the addition of the basal segment would alter the width-length ratio. The labium of *C. trinidadensis* Beardsley has a similar shape to the labium of *Xenococcus*.

The four genera *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* have many characters in common. The antennae and claws are remarkably similar and so unusual that a new tribe is here erected for the genera within the subfamily Pseudococcinae. In the absence of adult males it is not possible to give the relationship of the tribe.

Separation of the subfamilies Pseudococcinae and Rhizoecinae in this work is based mainly on the shape of the claw and the width-length ratio of the labium but it must be stressed that the species under discussion belong to aberrant genera which are not typical of the subfamilies.

Acknowledgements

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Abbreviations of the type-depositories mentioned in the text are as follows.

BMNH, London	British Museum (Natural History), London
IEAUN, Portici	Istituto di Entomologia Agraria dell'Università di Napoli, Portici
ITZ, Amsterdam	Instituut voor Taxonomische Zoölogie, Amsterdam
RNH, Leiden	Rijksmuseum van Natuurlijke Historie, Leiden
TARI, Taipeh	Taiwan Agricultural Research Institute, Taipeh
UM, Kuala Lumpur	University of Malaya, Kuala Lumpur
USNM, Washington	United States National Museum, Washington

Taxonomic treatment

An ideal classification of Coccoidea should be based on the taxonomy of adult males but so few males have been studied that identification is possible only with adult females which are neotenic. Female Pseudococcidae usually have three immature instars and males two immature and two pupal instars. There is often little to distinguish immatures from adult females in life apart from size. It is the experience of the writer, who has been engaged in identification of Coccoidea for many years, that identification of immature stages is often just as important to the collector as identification of the adult. When a new species is named, the name applies to all stages, not just to the stage mentioned in the description. In the present work available immature stages are discussed along with adult females.

PSEUDOCOCCINAE
ALLOMYRMOCOCCINI trib. n.

Type-genus: *Allomyrmococcus* Takahashi, 1941.

Pseudococcinae with body of adult female variously shaped, turbinate, or with abdomen rounded or abruptly narrowed at third segment. Head either membranous or heavily sclerotized when there is a deep constriction at about the prothorax. Anal lobes either wanting, in which case the anal lobe setae are short, or well developed with long anal lobe setae about as long as body. Anal ring usually sclerotized, terminal or situated a short distance from apex, with 6 setae but without pores except in one genus with minute pore-like structures. Antennae 6-segmented, stout, well developed and often as long as body, of a distinctive shape. The first segment on dorsum when mounted on slide, often large and wide; second segment short and not articulating with third segment. Remaining segments long, widest at distal end except the last segment, which is often depressed near middle of segment and variously curved. Fourth to sixth segments with abundant short setae, the distance between setal bases shorter than length of a seta. First and second segments with or without abundant setae. Longer and stouter sensory setae present on last segment. Legs well developed, long, the tarsus much shorter than tibia, often with numerous setae. Claw stout, each with a pair of flattened and expanded digitules, these about twice as long as claw and about same width. Labium conical, with 3 segments and with basic number of 14 pairs of setae but sometimes with as many as 32 pairs. Ostioles situated on edges of body when mounted on slide or lying on ventral surface, with an unusual development with heavily sclerotized and wide projecting lips, without setae or with posterior lip in form of sclerotized flap with numerous setae, the inner edges of lips joined by a membrane. Circulus present or absent. Body setae short, often abundant when they may cover the entire body surface except for intersegmental areas. When less abundant they may be accompanied with short blunt setae. Body pores often restricted to trilocular pores and simple pores but occasionally a few oral collar ducts may be present in mid-thoracic and anterior abdominal segments.

DISCUSSION. Based on the characters of the adult female, the tribe is one of the most distinctive in the family Pseudococcidae. As mentioned earlier in the section on classification, no adult males have been studied to give a clue to the relationship of the tribe. The evidence suggests that males exist and there is a pressing need for further observations in the areas where the tribe is known.

DISTRIBUTION. Thus far the tribe occurs in Thailand, West Malaysia (Malaya), Sarawak, Indonesia and Vietnam but the distribution may be extended after further study is made of nests of the ants *Hypoclinea* and *Polyrhachis*.

Key to genera of Allomyrmococcini (adult females)

- 1 Body without recognizable anal lobes, posterior end of body rounded, narrow, with short setae in normal positions of lobes. Body setae abundant on dorsal and ventral surfaces
PARAMYRMOCOCCUS (p. 54)
- Body with anal lobes, either poorly or well developed, with anal lobe setae about as long as body 2
- 2 Head heavily sclerotized and body constricted at prothorax. Long anal lobe setae and marginal setae on at least first preceding segment. Ostioles with posterior lip in form of a sclerotized flap which opens and closes against an apparently fixed sclerotized anterior lip. Anal ring narrow with minute pore-like structures
MALAIOCOCCUS (p. 30)
- Head membranous, body not constricted at prothorax. Long setae on anal lobes only or, if long marginal setae are present they are not on first preceding segment. Ostioles each with two sclerotized lips, the posterior lip similar to anterior lip. Anal ring with broad sclerotized rim without pores 3
- 3 Anal ring situated a distance about its own length from apex of abdomen, in a membranous depression in middle of sclerotized anal lobes. Body setae all pointed, densely covering dorsal and ventral surfaces, the distance between setal bases shorter than length of one seta. Legs about as long as body with abundant setae
ALLOMYRMOCOCCUS (p. 15)
- Anal ring terminal, at apex of dorsal lobe-like structure between ventral anal lobes. Body setae of two main types, one short and pointed and the other short and blunt, slightly clavate, the distance between setal bases greater than length of single seta. Legs shorter than body length with numerous setae but not densely covered; sometimes these setae are long and fleshy
HIPPEOCOCCUS (p. 20)

Key to genera of Allomyrmococcini (immature instars)

- 1 Body elongate-turbinate, without recognizable anal lobes, posterior end of body rounded with short setae in normal positions of lobes. Body setae mainly short and cylindrical on dorsum but with longer pointed setae on venter and around margins . *PARAMYRMOCOCCUS* (p. 54)
- Anal lobes developed to some extent even though poorly developed in some stages. Long anal lobe setae as long as body . 2
- 2 Head with some sclerotization even if only around the eyes, this sclerotization becoming more extensive in each successive stage. Long marginal setae on at least first preceding segment from anal lobes often as far forward as sixth preceding segment.
Body setae pointed but sometimes there are present also minute setae with the seta shorter than diameter of setal base. Anterior ostioles with posterior lip in form of flap
MALAIOCOCCUS (p. 30)
- Head always membranous. If long marginal setae are present they are not on first preceding segment from anal lobes . 3
- 3 Anal ring situated at least its own length from apex of body in a small membranous depression in middle of sclerotized anal lobes. Legs about as long as body (first instar not seen)
ALLOMYRMOCOCCUS (p. 15)
- Anal ring terminal at apex of sclerotized dorsal lobe-like structure between sclerotized ventral lobes. Legs long but shorter than body. Body setae pointed or long, fleshy and clavate
HIPPEOCOCCUS (p. 20)

ALLOMYRMOCOCCUS Takahashi, 1941

Allomyrmococcus Takahashi, 1941 : 201. Type-species: *Allomyrmococcus acariformis* Takahashi, by original designation and monotypy.

Only a single species is known so far. The genus has some peculiar characters among which are the unusually long stout legs about as long as the body. The turbinate shape, the well-developed anal lobes and dense covering of minute setae are some of the other most important characters. There is little information on its biology except that colonies are covered with a dense cluster of the ant *Dolichoderus* [= *Hypoclinea*] and the insects feed on young shoots. There is every indication that a honeydew channel or basket is formed between the anal lobes. The anal ring lies some distance from the apex of the abdomen and the space between the lobes is in the form of a concave depression which presumably retains honeydew.

DESCRIPTION. A broadly oval to turbinate body form with well-developed anal lobes each terminating with a group of stout setae about as long as body. Anal ring sclerotized, without pores but with 6 setae lying just outside the ring. Antennae 6-segmented, about as long as body, the second segment short and not articulated with the third; all segments densely covered with slender setae. Legs stout, as long as body or longer, covered with slender setae, tibia about four times as long as tarsus. Claw with a pair of flat expanded digitules, these about as wide as claw at base and twice as long. Body densely covered with minute pointed setae. Ostioles situated laterally, prominent, with well-developed sclerotized lips, without setae or trilocular pores. Labium stout but longer than wide with 30 or more pairs of setae in adult female, ventral or posterior surface with 2 pairs of posterior setae. Eyes present. Trilocular pores present but sparse.

Immature instars similar to adult female in form but smaller and with fewer body setae. No first instar available but second and third instars described here and illustrated.

DISTRIBUTION. At present the genus is known only from Thailand.

Allomyrmococcus acariformis Takahashi, 1941

Allomyrmococcus acariformis Takahashi, 1941 : 201. Holotype ♀, THAILAND: Mt Sutep, near Chiangrai, on plant of family Leguminosae, associated with ant *Dolichoderus* sp. [= *Hypoclinea* sp.] (TARI, Taipei).

Allomyrmococcus acariformis Takahashi; Takahashi, 1942 : 15.

Adult Female (Fig. 3)

DESCRIPTION. External appearance described originally as 'Dark reddish brown and blackish with no wax.'

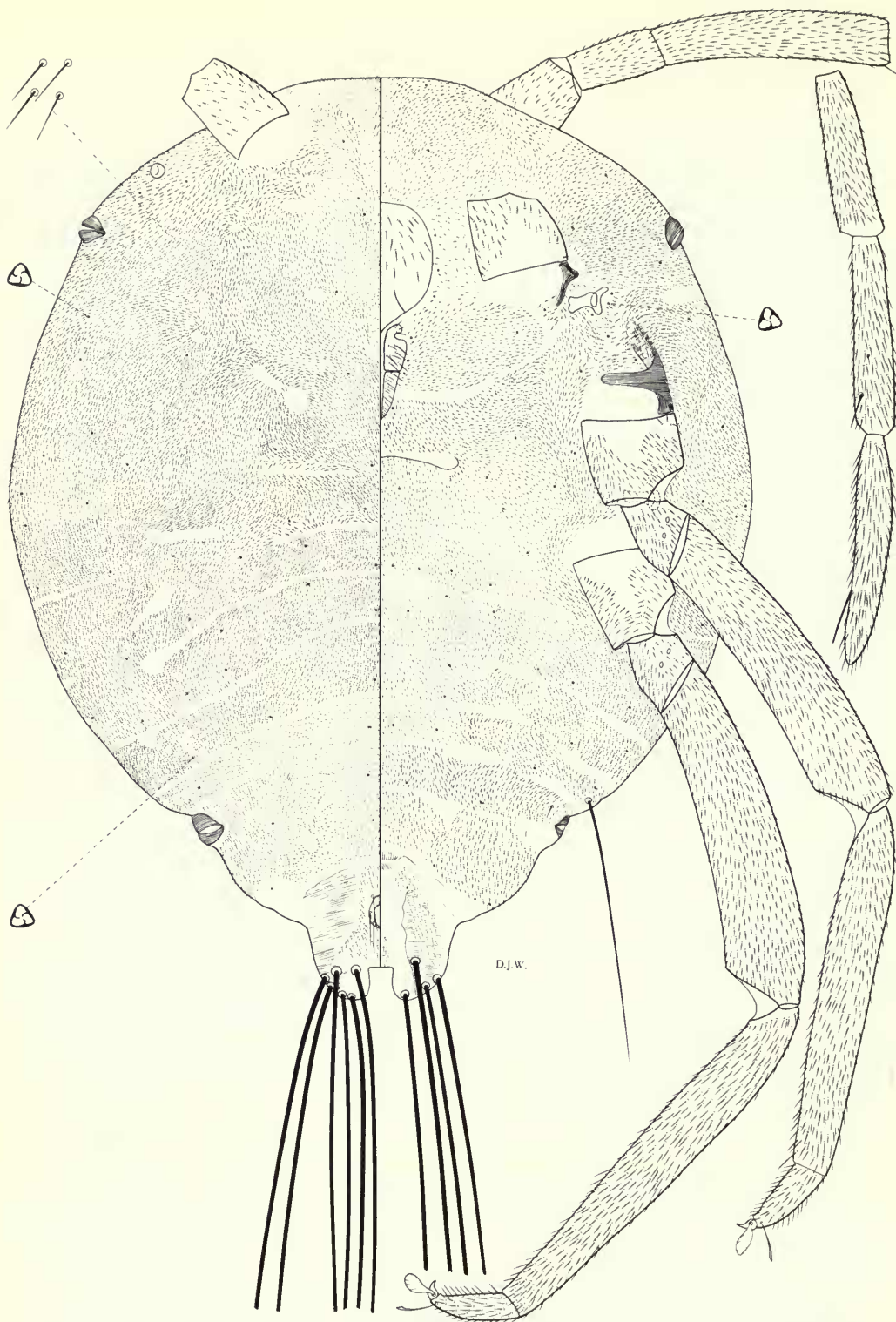


Fig. 3 *Allomyrmococcus acariformis* Takahashi. Adult female. Specimen from Thailand, Mt Sutep.

When mounted on the slide a broadly oval to turbinate species about 1.85 mm long and 1.4 mm wide, broad at anterior end and tapering posteriorly to a well-developed and protruding pair of rounded anal lobes. Antennae 1.81–1.92 mm long thus about as long as body; with 6 segments which on the longest antenna the first segment is 170 μ m long, the second 150 μ m, third 450 μ m, fourth 320 μ m, fifth 380 μ m and sixth 450 μ m, the last segment slightly curved, narrow at base but becoming 65 μ m at widest point a quarter of length from base before tapering to apex. Each segment densely covered with slender setae which on first segment are about 32 μ m long and commonly 70 μ m long on last segment. These setae also accompanied with a few long stout setae on apices of fifth and sixth segments. Legs quite long and well developed. Hind trochanter + femur 800–810 μ m long, hind tibia 750–850 μ m long and hind tarsus 170–190 μ m long, often curved inwards at an angle to tibia. All segments including coxae densely covered with slender setae, those on femur about 20 μ m long and on tibia about 48 μ m long. Claw stout 44 μ m long, each with a pair of stout flat digitules about twice as long as claw. Labium about 200 μ m long but width difficult to determine in available specimens. With 30–32 pairs of setae. Apical segment with 2 pairs ventral posterior setae, 1 pair minute apical setae, 4 pairs of subapical setae each 28 μ m long, 10 pairs of lateral and anterior setae the longest 40 μ m, 10–12 pairs of medial setae the longest 48 μ m, 3 pairs of basal setae the longest pair each 40 μ m long and 2 pairs each 24–32 μ m long. Clypeolabral plate with about 80 setae. Anal ring on dorsal surface about twice its diameter from posterior end of body, without pores but with 6 setae each about 80 μ m long. Ostioles large with thick heavily sclerotized and protruding lips, without setae. Circulus absent. Anal lobes sclerotized on both surfaces, this sclerotization extending forwards almost to level of vulva. Median dorsal surface between lobes membranous, depressed and forming a 'honeydew basket'. Each lobe with 6 dorsal and 4 ventral stout apical setae each about 1.5 mm long.

Body surface densely covered with slender pointed setae each about 16–20 μ m long, covering almost entire surface except for intersegmental areas. Spaces between setal bases much shorter than length of one seta, the spaces closer on dorsal surface than on ventral surface. The setae lie in various directions giving the surface a wavy appearance. Setal bases of two sizes, the larger size much fewer. A pair of stout setae each about 500 μ m long present on lateral edges of sixth abdominal segment. Trilocular pores sparse.

Third Instar Female (Fig. 4)

Similar to adult female but differing mainly in size. Body broadly oval and not so turbinate as in adult, 1.5 mm long and 1.25 mm wide. Anal lobes moderately developed. Antennae 6-segmented 1.35–1.42 mm long, the longest antenna with first segment 150 μ m long, second 120 μ m, third 300 μ m, fourth 220 μ m, fifth 270 μ m and sixth 360 μ m. All segments densely covered with slender setae but not so numerous as in adult, the setae ranging in length from 24 μ m on first segment to 60 μ m on sixth segment. Legs as in adult but shorter. Hind trochanter + femur 600–630 μ m long, hind tibia 550–570 μ m long and hind tarsus 150 μ m long. Claw stout, 40 μ m long with a pair of wide flat digitules about twice as long as claw. Labium 176 μ m long and 108 μ m wide, with 30–32 pairs of setae, distributed as in adult but differing in size. Lateral setae each about 40 μ m long, longest anterior seta 32 μ m long, longest medial seta 40 μ m long, 3 pairs of basal setae, the longest pair each 40 μ m long and the other 2 pairs each 20 μ m long. Clypeolabral plate with about 55 setae. Ostioles well developed, as in adult. Anal ring on dorsum about twice diameter from apex of body about 44 μ m wide with 6 setae each about 60 μ m long. Anal lobes sclerotized on dorsal and ventral surfaces, each lobe with about 9 stout apical and subapical setae 1.55 mm long. Median dorsal area between lobes forming a channel or 'honeydew basket'. Body setae slender, abundant and densely covering almost entire surface except for clear intersegmental areas, about 16–20 μ m long, the spaces between setal bases much shorter than length of one seta, dorsal setae tending to be closer together than ventral setae. A pair of lateral marginal setae present on sixth segment each about 400 μ m long. Trilocular pores not numerous.

Second Instar Female (Fig. 5)

This instar has similar characters to those of adult and third instar female but can easily be distinguished in possessing a pair of lateral setae on sixth abdominal segment each about 360 μ m long, a pair on dorsal lateral edge of fourth segment each about 550 μ m long and a submarginal pair on dorsum of prothorax each about 500 μ m long, the last 2 pairs with sclerotized areas around setal bases. Body ovoid, about 1.35 mm long and 1.0 mm wide, anal lobes moderately developed. Antennae 0.9 mm long, the first segment 110 μ m long, the second 80 μ m long, third 180 μ m, fourth 130 μ m, fifth 160 μ m and sixth 240 μ m long. Setae ranging from 24 μ m long on first segment to 36 μ m long on last segment. Legs with hind trochanter + femur 450 μ m long, hind tibia 390 μ m and hind tarsus 150 μ m; all segments densely covered with slender setae, those on disc of femur 16–20 μ m long and on disc of tarsus 32 μ m long. Claw 32 μ m long. Anal ring 40 μ m in diameter with 6 setae each 52 μ m long; situated about twice diameter

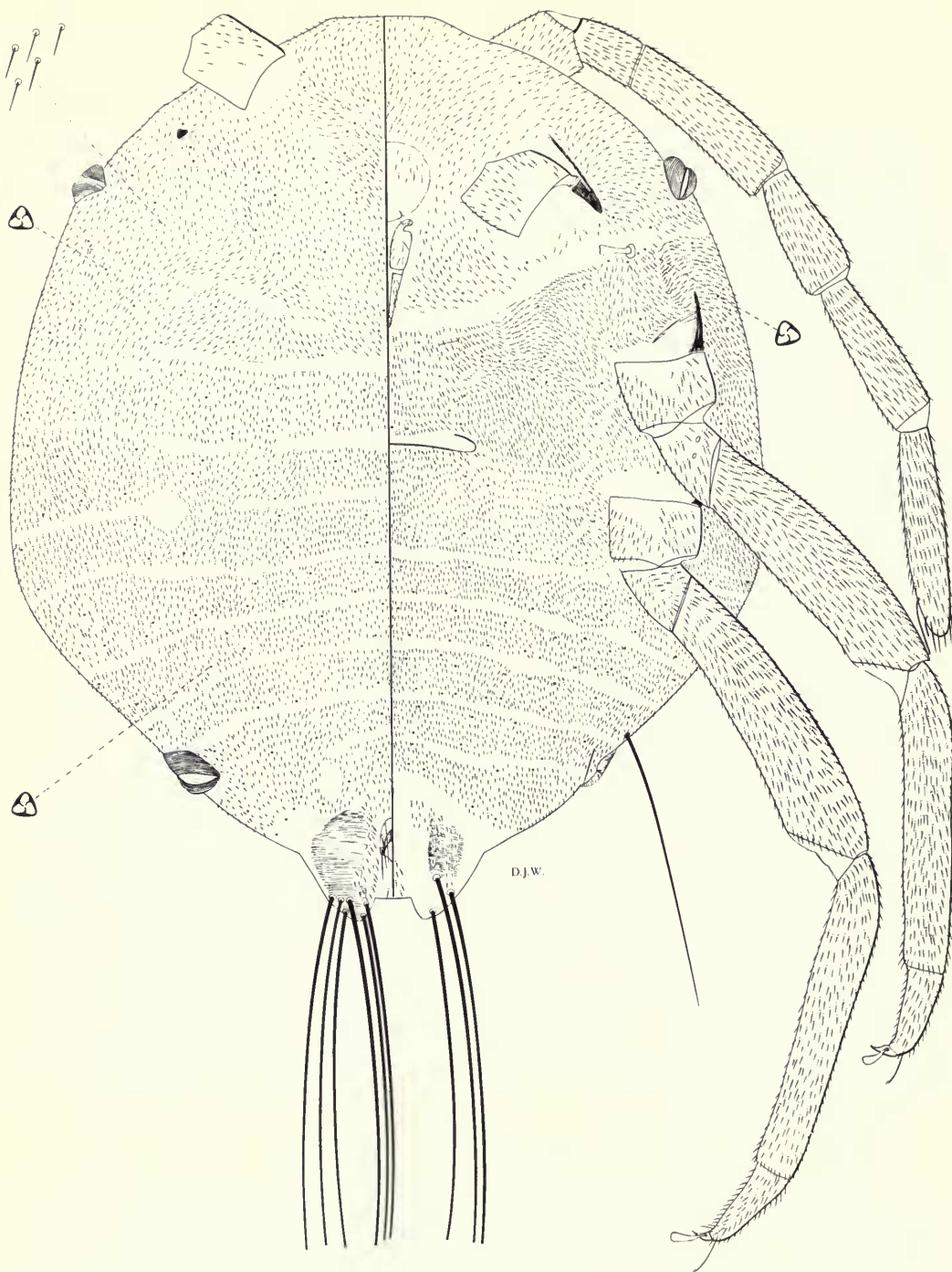


Fig. 4 *Allomyrmococcus acariformis* Takahashi. Third instar female.

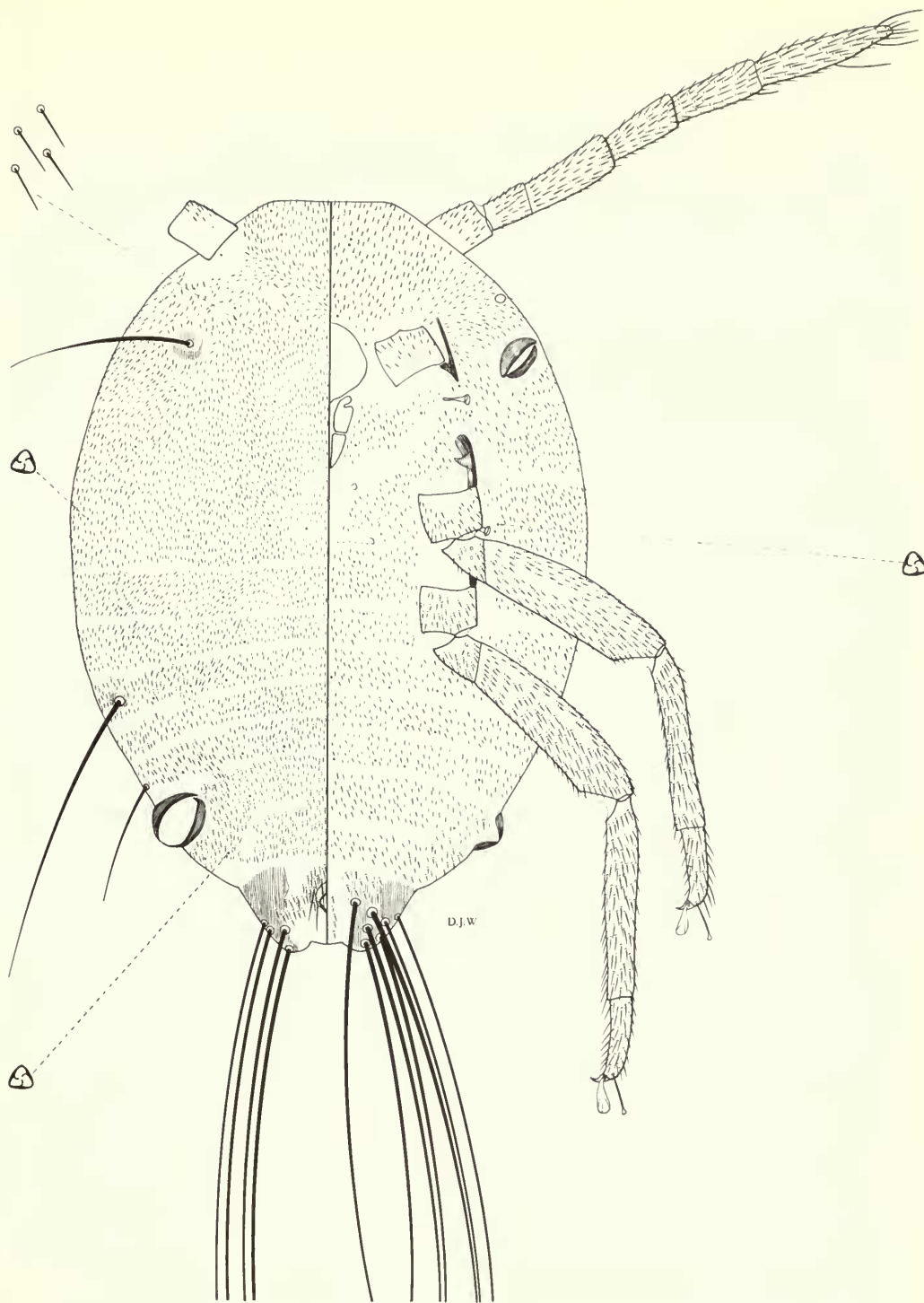


Fig. 5 *Allomyrmococcus acariformis* Takahashi. Second instar female.

from apex of body. Labium 132 μm long and 116 μm wide, with numerous setae as in third and adult instars but obscured in specimen available. Clypeolabral shield with numerous setae but difficult to count in available specimen. Ostioles with well-developed sclerotized lips, the anterior pair lying on ventral surface when mounted on slide. Anal lobes sclerotized, each with 11 apical and subapical setae about 1.5 mm long, their positions varying on dorsal and ventral surfaces but probably with 4 on dorsal surface and 7 on ventral surface. Body setae slender, about 16 μm long, covering almost entire surface except for intersegmental spaces, the distance between setal bases shorter than length of one seta. Trilocular pores few, scattered.

MATERIAL EXAMINED. THAILAND: 2 ♀, 'Siam', Mt Suteh, 5.iv.1940 (R. Takahashi; 1 third instar ♀ and 1 second instar ♀, same data as holotype (TARI, Taipeh).

This material has the same data as the holotype and it is assumed it is part of the original. The specimens have been kindly made available for study by Mr Charles Chia-chu Tao of the Taiwan Agricultural Research Institute, Taipeh.

HIPPEOCOCCUS Reyne, 1954

Hippeococcus Reyne, 1954 : 237. Type-species: *Hippeococcus rappardi* Reyne, by original designation.

This genus is known only from Java. It has some peculiar and unusual features connected with its mode of life. According to Reyne the species are invariably associated with ants of the genus *Dolichoderus* (= *Hypoclinea*). They are known to crawl on to ants' backs and are carried away when the ants are disturbed but large individuals may be carried in the ants' jaws. Found on the suckers and stems of the host, colonies are often covered with dense crowds of ants.

Reyne has given detailed descriptions of the species but there has been a pressing need for modern illustrations. The following descriptions, therefore, serve to supplement Reyne's and to accentuate the principal characters.

In common with most mealybugs there are four female instars and all of these are described for *H. wegneri* Reyne. Although Reyne mentioned only three instars it is possible that his descriptions of the second instar may include characters of the third also. Only three female instars are available here for *H. rappardi* Reyne; nevertheless, one or two specimens are at hand of what is presumed to be the second instar male and this is described. Reyne described the adult female before preparation as 'Body gleaming, without a coating of wax'.

DESCRIPTION OF ADULT FEMALE. Body broadly turbinate, seventh and posterior segments narrow. Venter of last segment folded on either side near the mid-line giving it the appearance, when viewed through the stereomicroscope, of forming two parallel tubes, the apices forming the anal lobes containing 5-7 long setae which may be almost as long as the body. The two tube-like parts of the last segment are covered dorsally with a triangular lobe containing setae of various lengths and which bears the anal ring at the apex. This ring is sclerotized, without pores, crescentic and contains 6 setae which increase in length and thickness posteriorly. The anal ring is usually on level with apices of the anal lobes but in one species the anal lobes are produced latero-posteriorly for a distance about same length again as last segment. Antennae 6-segmented, first segment normal, second quite small and usually wider than long, both segments with few setae. Third to sixth segments stout and elongate, containing numerous slender pointed setae, the total length of antenna about half length of body. Ostioles well developed, lying at sides of body, each with heavily sclerotized lips, the sclerotization surrounding anterior lips of first pair also extending around eyes. Without membranous lips, setae or trilocular pores. Setae on both surfaces of body abundant, mainly of two types, one of which is minute, clavate, usually 6-8 μm long, almost transparent, and the other type normal and pointed but short, about 20 μm long. Other setae, present on the posterior abdominal segments and legs, may be stout and long with a blunt tip or swollen apically and of a fleshy appearance. Only the basal part of these setae is sclerotized, the remainder becoming more transparent towards the apex. Claw stout, bearing a pair of quite wide and flat digitules each usually about as wide as the claw and about twice as long. Trilocular pores present. Circulus oval.

DESCRIPTION OF IMMATURE INSTARS. Normally turbinate but becoming wider at each instar. Anal lobes and dorsal triangular lobe containing anal ring present in all stages. Minute transparent clavate setae absent. Short pointed setae absent in first instar but becoming more numerous in each successive stage. Antennae of first instar with thickened long setae only. Second instar with abundant short setae on third to sixth antennal segments and these setae become more numerous in successive instars.

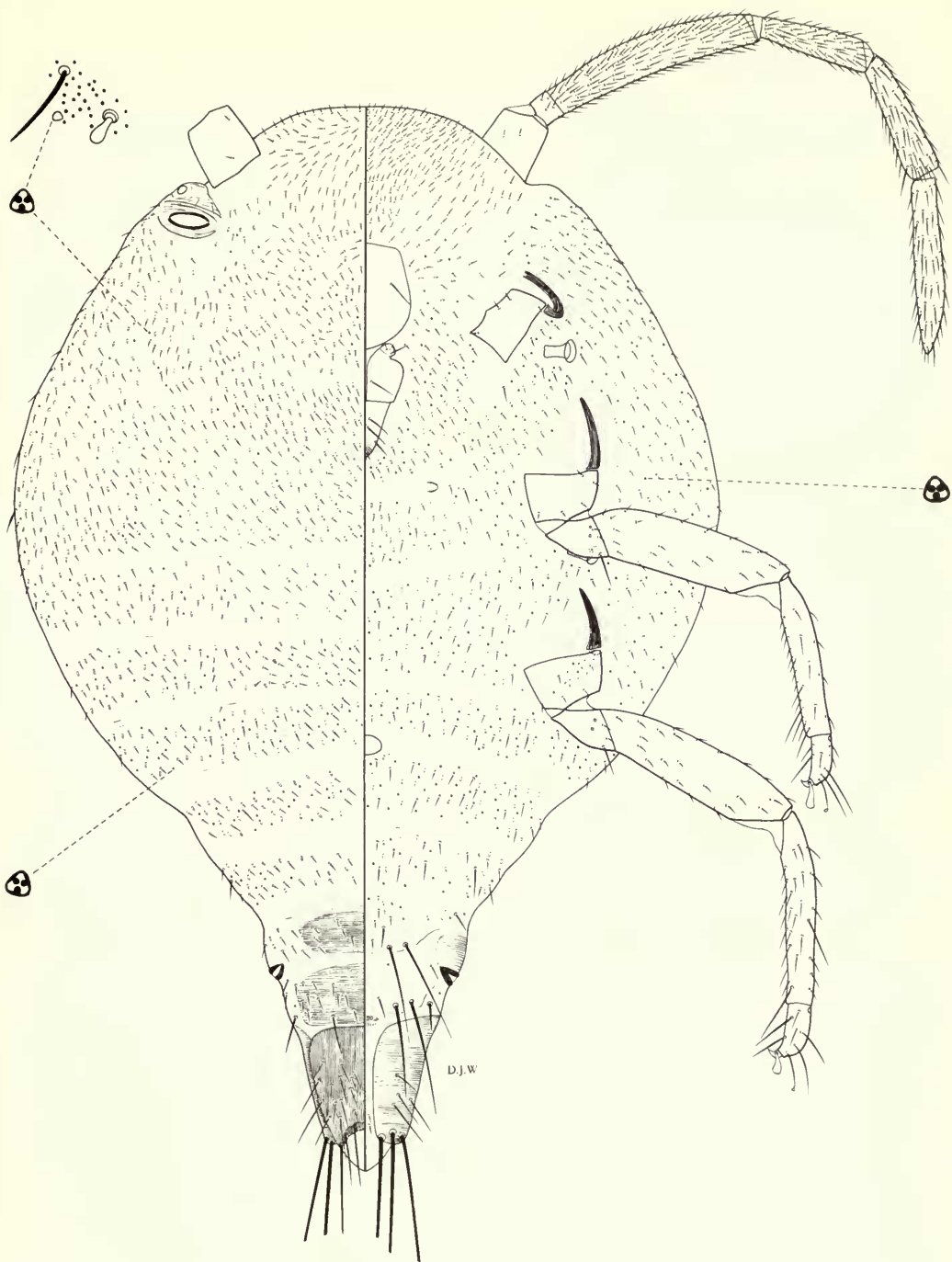


Fig. 6 *Hippeococcus rappardi* Reyne. Adult female. Specimen from Java, Mt Kawai.

Key to species of *Hippeococcus* (adult females)

- 1 Anal lobes projecting about the length of last segment from level of anal ring *montanus* Reyne (p. 22)
- Anal lobes terminating at about same level as anal ring 2
- 2 Ventral surface of abdomen with numerous stout or expanded setae in addition to long setae on seventh and posterior segments. Anal lobes each with 6 long apical setae *wegneri* Reyne (p. 26)
- Ventral surface of abdomen without numerous expanded setae, short pointed setae present only except for long setae on seventh and posterior segments. Anal lobes each with 5 long apical setae *rappardi* Reyne (p. 22)

Immature instars

A few instars have not been available for study and it is not possible to give a workable key. The first instars of *H. rappardi* and *H. wegneri* have thick, fleshy and clavate setae on the dorsal and ventral surfaces but in *H. rappardi* there are 2 long pointed setae on each side of sixth and seventh segments. In *H. wegneri* there is 1 long seta and 1 short blunt seta in these positions. The thick clavate setae persist in the second and third instars of *H. wegneri* but in *H. rappardi* they are replaced by pointed setae. Instars are mainly distinguished by an increase in antennal and leg lengths. The second instar males are easily recognized by the presence of multilocular disc pores and oral collar tubular ducts.

Hippeococcus montanus Reyne, 1954

Hippeococcus montanus Reyne, 1954 : 250. Holotype ♀, JAVA [lost] (named from drawings in ITZ, Amsterdam).

There are no specimens available of this species as Reyne (1954) named it from certain drawings made by P. van der Goot possibly in 1915. The illustration has the appearance of being accurately executed. Although obviously a *Hippeococcus* species, it differs from *H. rappardi* and *H. wegneri* in having quite long and prominent anal lobes that are set rather wide apart and protrude about the same distance as the length of base or dorsal lobe covering them. In the other two species the anal lobes are about the same length as the dorsal lobe.

Other than living in Java there is no further information on its locality but from the illustration reproduced by Reyne, it should be easy to identify the insect when collected again.

Hippeococcus rappardi Reyne, 1954

Hippeococcus rappardi Reyne, 1954 : 239. Holotype ♀, JAVA: East, Yang Mts, Gondang Plantation, on *Ficus variegata*, 21.vii.1950 (RNH, Leiden) [examined].

Adult Female (Fig. 6)

Body broadly turbinate, about 2.1 mm long and 1.45 mm wide, posterior segments tapering. Anal lobes heavily sclerotized ventrally and with the dorsal surface forming lobe covering median area of last segment, with anal ring at apex. Seventh and eighth segments sclerotized mid-dorsally, and areas of sclerotization present around the well-developed ostioles and around the eyes. Entire surface with minute sclerotized dots that give the body a slightly dark appearance even when not stained. Antennae about 1.55 mm long, the third to sixth segments densely covered with slender setae, those on the third segment 52–60 µm long and those on sixth segment thicker and usually 100 µm long. Legs well developed, hind trochanter + femur 530 µm long, hind tibia + tarsus 540–560 µm long, hind coxa with a few translucent pores. Setae on legs of various sizes, on the hind tarsus they range from stiff pointed setae 40–100 µm long on the inner edge to stout fleshy setae, pointed, 52–160 µm long on the outer edge. Claw about 44 µm long. Labium 180 µm long and 140 µm wide with 14 pairs of setae. Apical segment with two pairs of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae each 32 µm long, 1 pair lateral setae each 52 µm long and 2 pairs of anterior setae each 68 µm long. Medial segment with a single pair of medial setae each 60 µm long and basal segment with 3 pairs basal setae, 1 pair 32 µm long and 2 pairs each 20 µm long. Circulus oval, about 74 µm wide. Anal ring at apex of abdomen, about 88 µm wide, with 6 setae, these becoming distinctly longer in a posterior direction, the posteriormost quite thick.

Dorsal setae of two main types. On all segments anterior to eighth there are numerous minute clavate setae with a fleshy appearance, each about 6 µm long. Other dorsal setae pointed, numerous and usually 26 µm long. On the posterior abdominal segments the setae become longer. Trilocular pores not numerous.

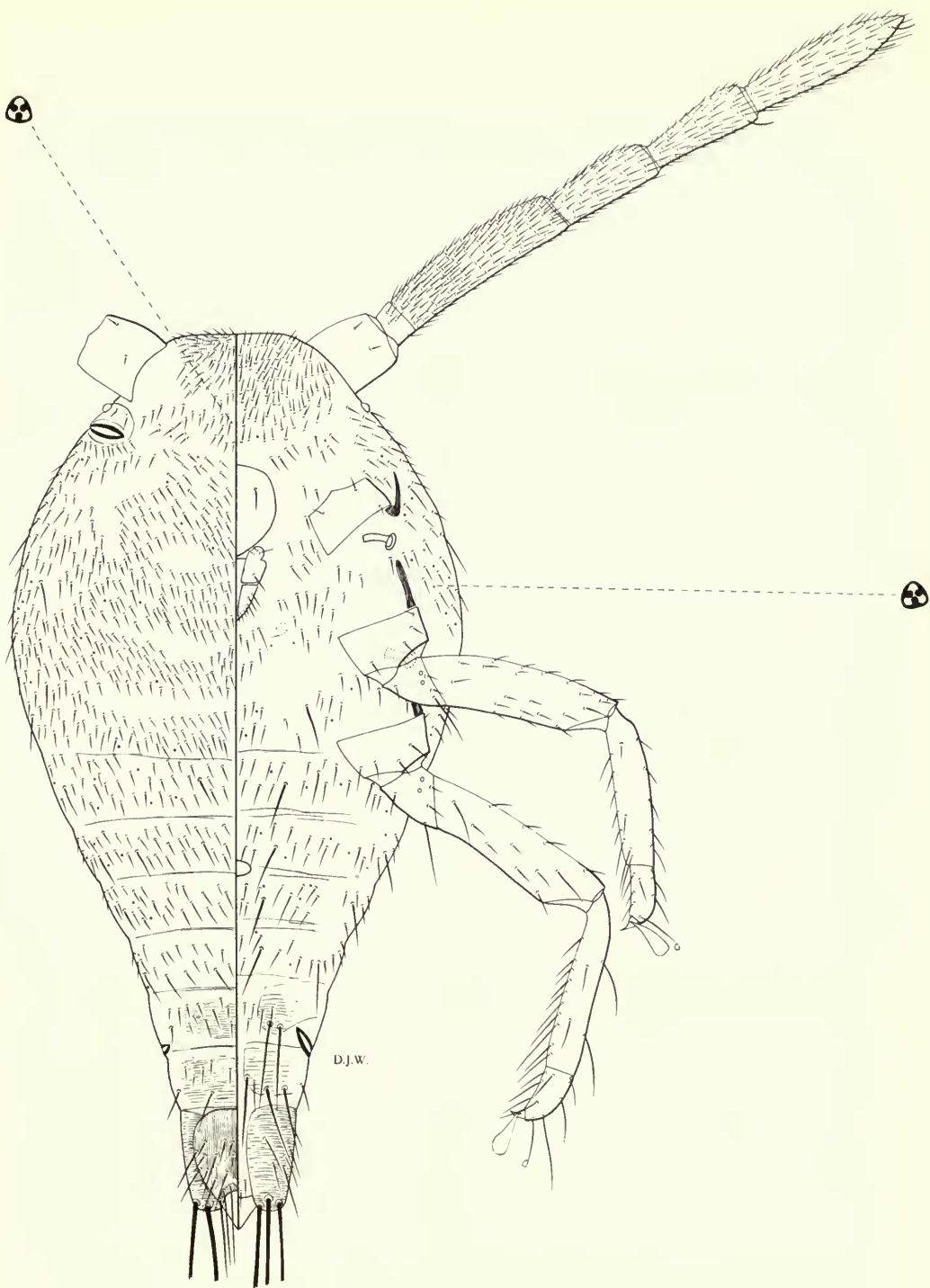


Fig. 7 *Hippeococcus rappardi* Reyne. Third instar female.

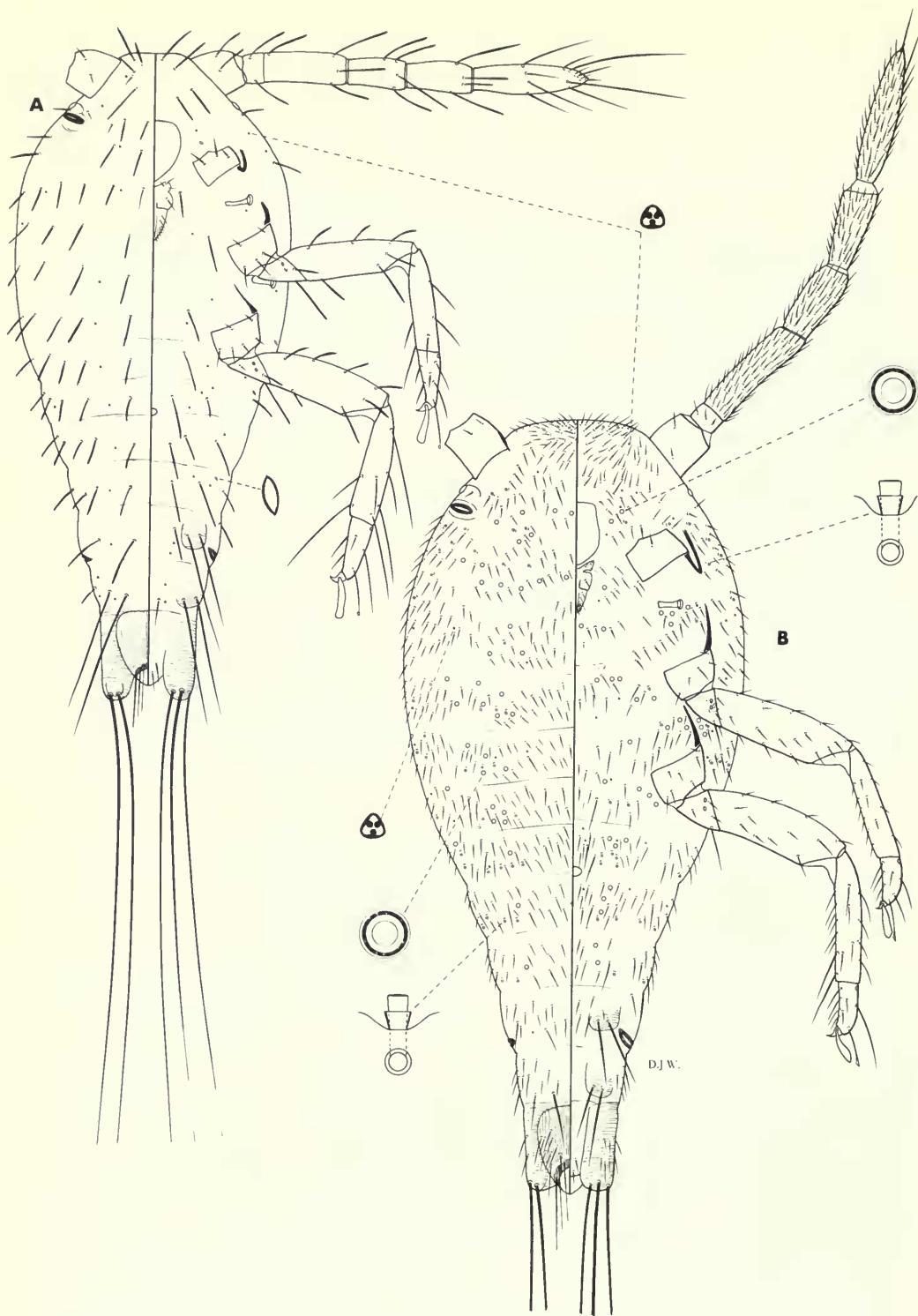


Fig. 8 *Hippeococcus rappardi* Reyne. (A) First instar. (B) Second instar male.

Ventral surface with numerous minute blunt setae as on dorsum but they are absent between antennae and on eighth and posterior segments. Other setae pointed, about $26\text{ }\mu\text{m}$ long except for longer setae near abdominal margins and for long setae $180\text{--}200\text{ }\mu\text{m}$ long on the seventh and eighth segments. Trilocular pores tending to be more numerous than on dorsum but absent on head.

Third Instar Female (Fig. 7)

Body about 1.75 mm long and 0.75 mm wide, elongate, widest on thorax, abdomen tapering. Seventh and eighth segments with distinct sclerotization in mid-regions. Anal lobes and dorsal median lobe heavily sclerotized. Antennae 1.2 mm long, third to sixth segments with numerous short setae. Hind trochanter + femur $450\text{ }\mu\text{m}$ long, hind tibia + tarsus $460\text{ }\mu\text{m}$ long. Claw about $36\text{ }\mu\text{m}$ long. Labium $148\text{ }\mu\text{m}$ long and $100\text{ }\mu\text{m}$ wide with same number of setae as in adult and about same size. Circulus oval, $56\text{ }\mu\text{m}$ wide. Ostioles present at edges of body, similar to those of adult but smaller. Body setae short and pointed only, with a similar distribution to those of adult female, but less numerous; mid-dorsal setae about $40\text{ }\mu\text{m}$ long and a typical short ventral seta about $40\text{ }\mu\text{m}$ long. Seventh and eighth segments sclerotized over most of the area. On the seventh segment most of the setae lie in the sclerotized area and on the eighth segment all the setae lie within the sclerotized area. Some long ventral setae on segments 7 and 8 stout and longer than the segments.

Second Instar Male (Fig. 8B)

The writer agrees with Reyne (1954) that this is the second instar male rather than the female because the body has a vestiture of numerous tubular ducts and multilocular disc pores. Although second instar females of other mealybugs may possess similar pores and ducts they usually become more numerous in the third and adult instars. In this species they are absent completely in the third and adult female instars. Numerous pores and ducts in the second instar male are present to secrete the pupal covering.

Body elongate, abdomen tapering, about 1.35 mm long and 0.55 mm wide. Antennae $800\text{ }\mu\text{m}$ long, the third to sixth segments densely covered with short slender setae. Legs well developed, hind trochanter + femur $300\text{ }\mu\text{m}$ long, hind tibia + tarsus $340\text{ }\mu\text{m}$ long. Claw $28\text{ }\mu\text{m}$ long. Labium $120\text{ }\mu\text{m}$ long and $100\text{ }\mu\text{m}$ wide with 14 pairs of setae, common to the species. Dorsal labial setae shorter than those of previous stages, subapical setae each $24\text{ }\mu\text{m}$ long, lateral setae $36\text{ }\mu\text{m}$ long, anterior setae each $40\text{ }\mu\text{m}$ long. Medial segment with medial setae $52\text{ }\mu\text{m}$ long and basal segment with 1 pair basal setae $32\text{ }\mu\text{m}$ long and 2 pairs each $16\text{ }\mu\text{m}$ long. Circulus oval, about $20\text{ }\mu\text{m}$ wide. Ostioles well developed, on edges of body. Anal ring $64\text{ }\mu\text{m}$ wide.

Dorsal setae all pointed, numerous, a mid-dorsal seta usually about $24\text{ }\mu\text{m}$ long. Longer setae present also on the lobe-like structure above anal lobes. Multilocular disc pores present, mainly in submedian areas of thorax and anterior abdominal segments. Oral collar tubular ducts, each with the internal collar flange-shaped and occupying about half length of duct, situated among the multilocular disc pores and extending to margin. Trilocular pores sparse.

Ventral surface with numerous pointed setae tending to be longer than those on dorsum, a common length being about $32\text{ }\mu\text{m}$. Two pairs of sclerotized areas on seventh and eighth segments each with a pair of long pointed setae. Multilocular disc pores in mid-regions of thorax, anterior abdominal segments and near spiracles. Tubular ducts present near the multiloculars and towards the margins. Trilocular pores few.

First Instar (Fig. 8A)

Body narrowly turbinate, about 1.2 mm long and 0.4 mm wide at the thorax. Anal lobes and dorsal surface forming lobe, heavily sclerotized. Anal ring about $60\text{ }\mu\text{m}$ wide, without pores but with 6 setae at anterior or dorsal half of the ring. These setae become progressively thicker and longer posteriorly, the longest about $160\text{ }\mu\text{m}$. Anal lobes with 2 long dorsal setae and 3 ventral setae, each about 0.95 mm long. Antennae 6-segmented, about $630\text{ }\mu\text{m}$ long with a few long setae slightly expanded distally, on each segment except last where they are pointed. Legs well developed, hind trochanter + femur $220\text{ }\mu\text{m}$ long, hind tibia + tarsus about $310\text{ }\mu\text{m}$ long. Claw $28\text{ }\mu\text{m}$ long. Labium $120\text{ }\mu\text{m}$ long and $88\text{ }\mu\text{m}$ wide, the dorsal setae tending to be shorter than in previous stage; subapical setae $24\text{ }\mu\text{m}$ long, lateral setae $36\text{ }\mu\text{m}$ long, anterior setae each $32\text{ }\mu\text{m}$ long, medial setae $36\text{ }\mu\text{m}$ long and basal setae with 1 pair $32\text{ }\mu\text{m}$ long and 2 pairs each $12\text{ }\mu\text{m}$ long. Ostioles well developed, without setae but with lips heavily sclerotized. Circulus small and oval about $20\text{ }\mu\text{m}$ wide.

Dorsal setae slightly expanded towards apex, each with a fleshy appearance and about $56\text{ }\mu\text{m}$ long on mid-abdomen where there are about 8 across a segment. Eighth segment with 2 pairs of long pointed setae reaching beyond anal lobes. Trilocular pores few, forming a single submedian row and with one or two around margins.

Ventral surface with setae similar to those on dorsum but tending to be longer, up to 60 μm , except the submarginal setae on seventh and eighth segments which are long and pointed, in pairs, on lightly sclerotized areas. Trilocular pores few, in submedian areas. Simple pores few on submargins, each about same size as a trilocular pore but usually oval in shape.

MATERIAL EXAMINED. *Hippeococcus rappardi* Reyne, holotype ♀, JAVA: East, Yang Mts, Gondang Plantation (RNH, Leiden).

JAVA: Immatures with same data as holotype; immature instars, Mt Kawi, Gaden, on young shoots of *Litsea* sp. (Lauraceae), ii.1951 (*F. W. Rappard*) (RNH, Leiden); 1 ♀ and immatures, same data but labelled from *Litsea* sp., *Eugenia* sp. [Myrtaceae] and *Rubus* sp. [Rosaceae] (BMNH, London).

Recorded also by Reyne (1954) from JAVA: Gondang, on *Ficus variegata*, on suckers of *Eugenia* sp. and *Litsea confusa*; from Gaden, on stems of *Rubus* sp. and *Eupatorium* sp. (Compositae).

Hippeococcus wegneri Reyne, 1954

Hippeococcus wegneri Reyne, 1954: 255. Holotype ♀, JAVA: West, Tjibodas, Botanical Garden, from nest of *Dolichoderus* (= *Hypoclinea*) *gibbifer* Emery, i.1953 (RNH, Leiden) [examined].

Adult Female (Fig. 9)

Body broadly turbinate, attaining a length of 2.75 mm and a width of 2.0 mm, abdomen narrowing abruptly. Anal lobes and dorsal surface of eighth segment heavily sclerotized. Sclerotization also in dorsal median areas of fifth to seventh segments and in ventral submedian areas of seventh and eighth segments. Anal lobe setae comprising three dorsal and four ventral, each about 1.5 mm long. Entire surface with minute sclerotized dots giving the membranous body the appearance of being lightly sclerotized. Antennae about 1.5 mm long with abundant slender setae on third to sixth segments. Setae on third segment about 60 μm long, becoming progressively longer to sixth segment where they are thicker and 90–100 μm long. Legs well developed, hind trochanter+femur 570–590 μm long, hind tibia+tarsus 600–620 μm long. Claw 40 μm long. Setae on legs of different shapes; they are long clavate and thick with a fleshy appearance, or short or long and pointed, the longest on the outer side of tibia and tarsus. On the tarsus the pointed setae are 40–160 μm long and the stout fleshy setae 40–180 μm long. Hind coxae with a few translucent pores. Labium 184 μm long and 120 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, a pair of slender lateral setae each 48 μm and 2 pairs of thick fleshy anterior setae each 80 μm long. Medial segment with 1 pair of fleshy setae each 92 μm long and basal segment with 2 pairs of short pointed setae each 20 μm long and a pair of fleshy setae each 44 μm long. Circulus about 68 μm wide. Anal ring 84 μm wide, on level with apices of anal lobes, the anterior pair of setae 100 μm long, the median pair 140 μm long and the posterior pair 180 μm long, these setae becoming thicker as they become longer.

Dorsal surface anterior to seventh segment with numerous minute clavate setae each 6–8 μm long, of a fleshy appearance, barely taking up the stain. Short pointed setae each about 20 μm long, evenly distributed. Posterior abdominal segments with a few clavate or thick setae ranging in length from 30 to 120 μm , the dorsal lobe covering anal lobes with a few thick setae about 60 μm long. Trilocular pores in moderate numbers, evenly distributed.

Ventral surface with similar minute clavate and pointed setae as on dorsum, on sixth and anterior segments. Long clavate or thick and bluntly pointed setae present across the abdominal segments ranging in length from about 60 to 90 μm except for some on seventh, eighth and anal lobe segments that may be up to 260 μm long. Trilocular pores numerous with an even distribution.

Third Instar Female (Fig. 10)

Body a similar turbinate shape to that of adult female but narrower, 2.0 mm long and 1.0 mm wide. Sixth and posterior segments sclerotized with the 3 dorsal and 3 ventral anal lobe setae about 1.5 mm long. Antennae 1.13 mm long, the third to sixth segments densely covered with short setae which become longer towards the last segment. Hind legs with trochanter+femur 450 μm long, hind tibia+tarsus 480 μm long. Claw about 30 μm long. Labium 152 μm long and 120 μm wide, with 14 pairs of setae but these shorter than in adult. Subapical setae each 26 μm long, lateral setae each 36 μm long, the 2 pairs of anterior setae each 56 μm long, thick and fleshy. Medial segment with medial setae thick, each 68 μm long and basal segment with 2 pairs of short pointed setae each 16 μm long and 1 pair of thick setae each 56 μm long. Circulus oval, 68 μm wide. Anal ring about 68 μm wide. Body setae of two main types,

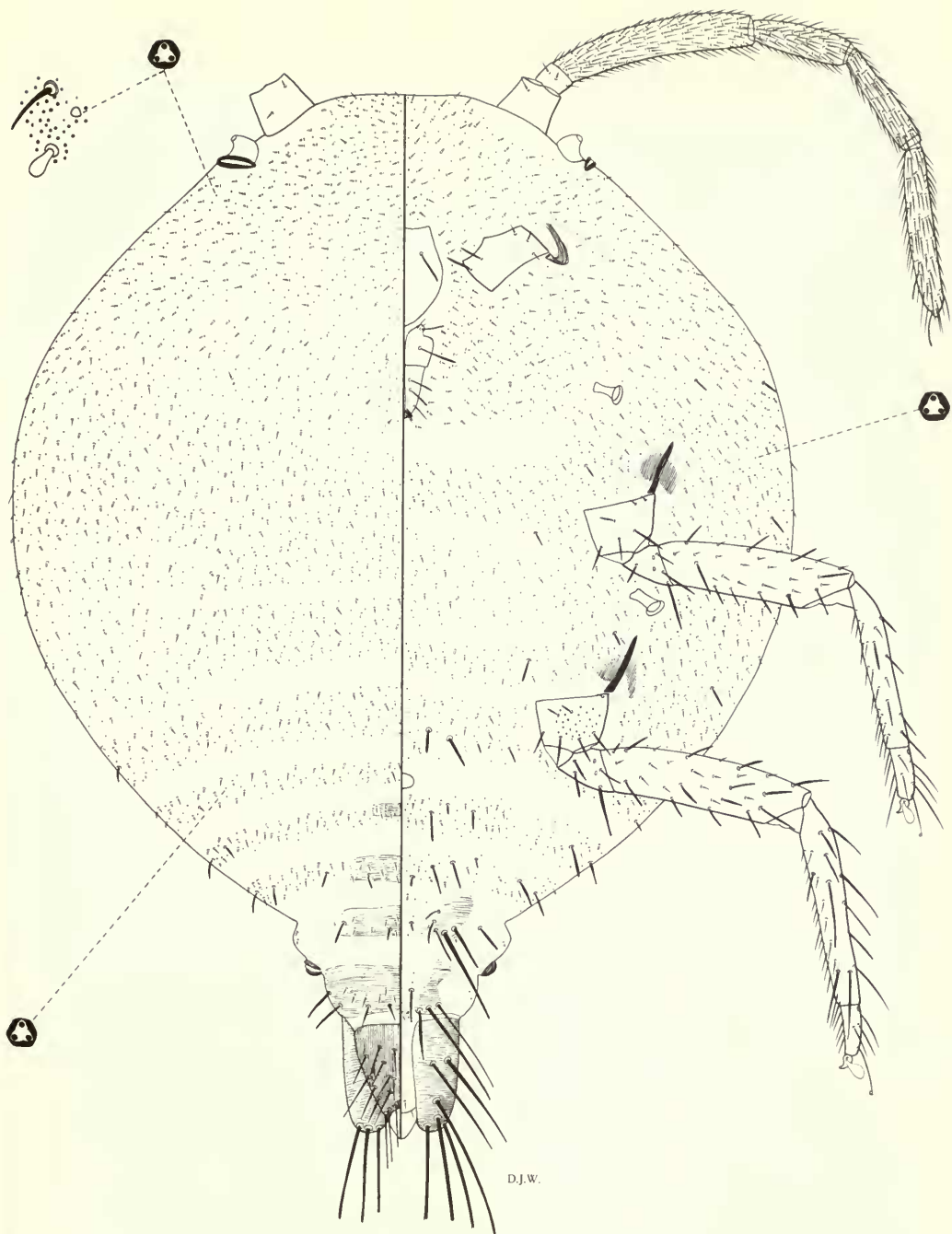


Fig. 9 *Hippeococcus wegneri* Reyne. Adult female. Specimen from Java, Tjibodas.

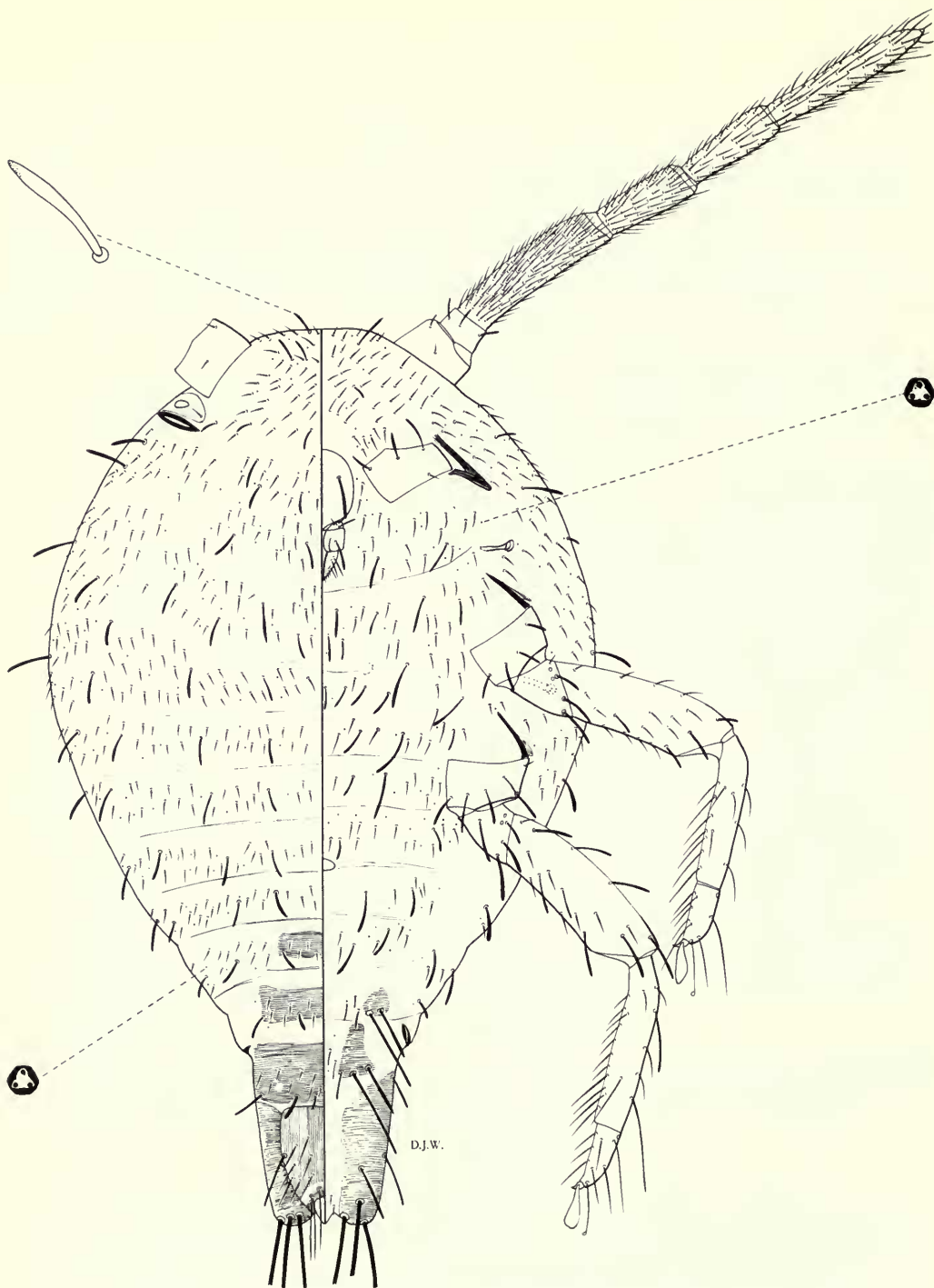


Fig. 10 *Hippeococcus wegneri* Reyne. Third instar female.

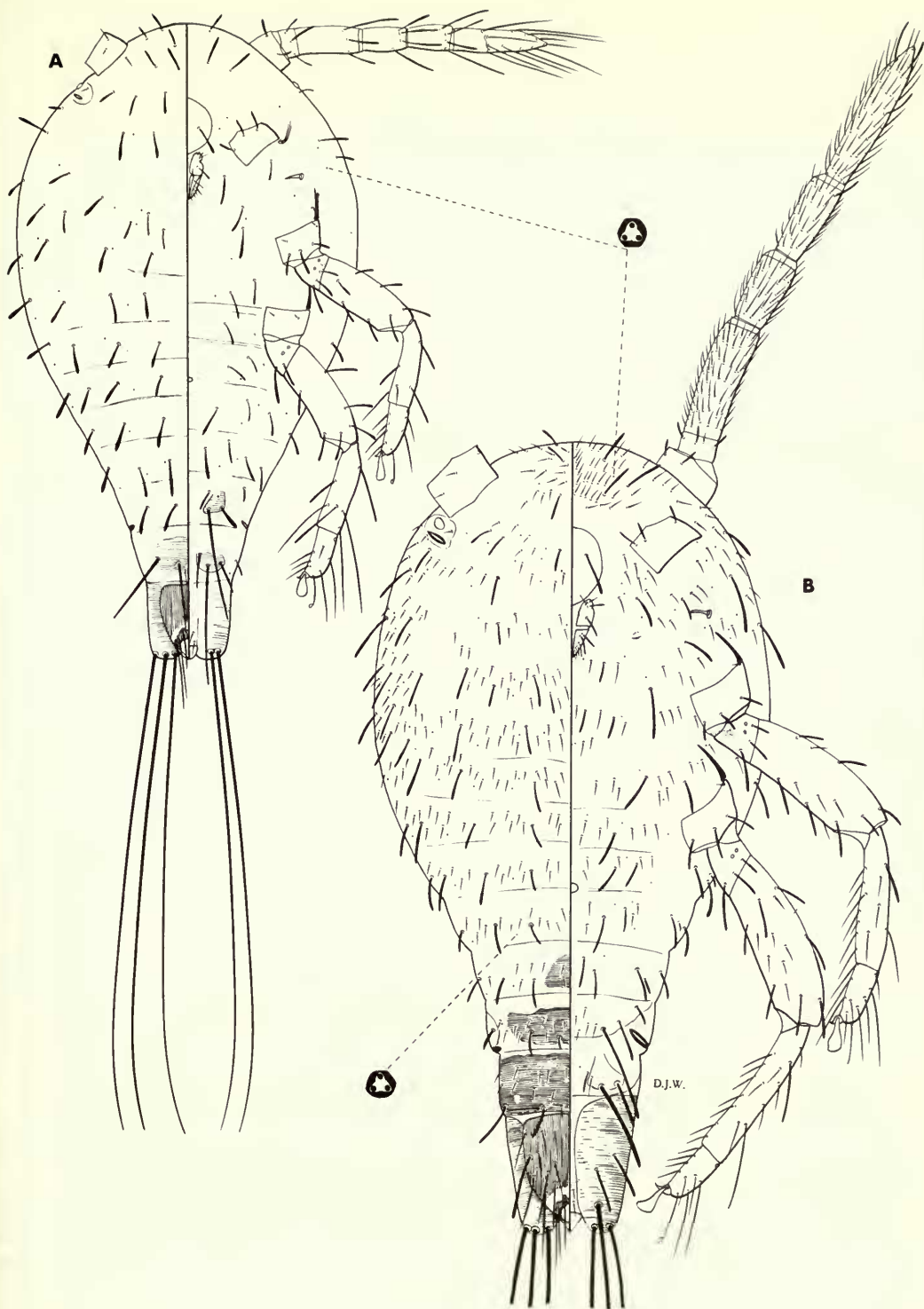


Fig. 11 *Hippococcus wegneri* Reyne. (A) First instar. (B) Second instar female.

a clavate or expanded type, thick and fleshy, ranging in length from 50 to 100 μm except at posterior end of body where some are longer on ventral surface, and short pointed setae, which are numerous and interspersed among the fleshy setae. The minute clavate setae are absent in this instar. Trilocular pores sparse.

Second Instar Female (Fig. 11B)

Body narrowly turbinate, abdomen tapering, 1.4 mm long and 0.7 mm wide. Sclerotization at posterior end of body on anal lobes, on dorsal surface of eighth segment and in median areas of seventh and sixth segments. Legs with hind trochanter + femur 370 μm long, hind tibia + tarsus 390 μm long. Claw about 28 μm long. Antennae 900 μm long, third to sixth segments with numerous slender setae. Ostioles less developed than in previous stage. Circulus about 40 μm wide. Labium with 14 pairs of setae. Apical segment with 4 pairs of subapical setae each 24 μm long, a pair of slender lateral setae each 36 μm long and 2 pairs of thick fleshy anterior setae each 48 μm long. Medial segment with 1 pair of fleshy setae each 56 μm long and basal segment with 2 pairs of slender setae 12 μm long and a pair of thick setae each 44 μm long. Body setae with similar distribution of clavate type to those in third stage but short pointed setae less numerous especially on head and ventral thorax, the short dorsal setae about 24 μm long and the ventral setae about 32–40 μm long. The clavate setae range in length from 50 to 100 μm long except at posterior end of body where some are 160 μm long. Anal lobe setae difficult to measure but all are over 1.0 mm long. Trilocular pores sparse on both surfaces.

First Instar (Fig. 11A)

Body narrowly turbinate, about 1.35 mm long and 0.7 mm wide, anal lobes each with 3 dorsal and 2 ventral setae at apices, about 1.3 mm long. Anal lobes and dorsal lobe-like structure covering anal lobes heavily sclerotized. Antennae 630 μm long with clavate setae on all segments except last, which has long pointed setae. Legs well developed, hind trochanter + femur 300 μm long, hind tibia + tarsus 320 μm long. Claw 24 μm long. Labium 108 μm long and 80 μm wide, with 14 pairs of setae, all slender except for medial setae which are thick and fleshy. Apical setae each 24 μm long, lateral setae each 28 μm long, anterior setae each 40 μm long. Medial segment with medial setae 56 μm long and basal segment with 2 pairs of basal setae 12 μm long and 1 pair 32 μm long. Ostioles small but with lips heavily sclerotized. Circulus oval, about 20 μm wide. Anal ring 44 μm wide with 6 setae which become progressively longer posteriorly, the second pair twice as long as anterior pair and posterior pair half as long again as median pair.

Dorsal surface without short pointed setae but with long-clavate setae ranging in length from 40 to 68 μm . Eighth segment with 4 stout pointed setae as long as anal lobes. Trilocular pores sparse.

Ventral surface with similar clavate setae to those on dorsum but some are longer, approaching 80 μm long. Long stout clavate to pointed setae present also on small sclerotized areas on seventh and eighth segments. Trilocular pores few.

MATERIAL EXAMINED. *Hippeococcus wegneri* Reyne, holotype ♀, JAVA: West, Tjibodas, Botanical Garden, i.1953 (*A. M. R. Wegner*) (RNH, Leiden).

JAVA: immatures, same data as holotype; paratypes and immatures, same data, 1 ♀ on young shoots and fruit of *Diospyros kaki* [Ebenaceae] (RNH, Leiden), 1 ♀ (ITZ, Amsterdam); 6 ♀ and immatures, i.1953 (*A. M. R. Wegner*); 2 ♀, vi.1953 (*A. M. R. Wegner*); 1 ♀ Tjibodas, 22.x.1973 (*B. Bolton*) (BMNH, London).

Recorded also by Reyne (1954) on *Cyclanthera explodens* (Cucurbitaceae).

MALAIOCOCCUS Takahashi, 1950

Malaicoccus Takahashi, 1950: 65. Type-species: *Malaicoccus riouwensis* Takahashi, by original designation.

This is an unusual genus of the Pseudococcidae in that the known species have the prothorax constricted and most of the head is heavily sclerotized. In life they have a strong resemblance to aphids and may often be mistaken for them. All are associated with ants of the genera *Polyrhachis* and *Hypoclinea* but little is known of their life history or habits. The mealybugs are attended by the ants which often carry them in their mandibles at the constriction on the prothorax.

DESCRIPTION OF ADULT FEMALE. Body form ovoid to globular with a definite constriction on prothorax opposite first coxae. Head heavily sclerotized around antennal bases, the sclerotization often extending to

first pair of ostioles; the front of head on ventral surface almost completely sclerotized forward from clypeus. Antennae 6-segmented, often longer than entire body and densely covered with slender setae; the first segment arising from dorsal surface. Second segment short and not articulating with third segment. Legs well developed, often with numerous setae of different sizes. Claws stout, with flattened digitules which are greater in size than claw itself. Labium conical with 21–32 pairs of setae, always with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae and 1 pair of lateral setae. The supernumerary setae occur in the anterior and medial groups. Circulus present, usually well developed with deep lateral constrictions. Ostioles of a distinctive type, the anterior pair each with an apparently fixed anterior lip which is arc-shaped. A heavily sclerotized semi-circular lower lip containing a few setae is hinged to close over to the anterior lip. These ostioles often lie on ventral surface on slides due to convexity of body or more often on margins so that they are viewed in lateral aspect. Posterior ostioles with anterior lip apparently fixed and with the posterior lip narrower than in anterior ostiole, with or without small setae. Anal ring terminal, narrow, with a few minute pores and 6 setae. Two crescentic or triangular areas of sclerotization containing setae present at either side of anal ring or just anterior to it. The anal ring is depressed behind the crescentic areas so that apex of abdomen forms a small 'honeydew basket'. Setae on margins of last 2–4 segments about as long as body and often accompanied with 1 or 2 short setae. Body setae minute, always numerous and sometimes densely covering the surface in which case the distance between the setal bases is shorter than the length of a seta. Other setae stout, of various lengths. Posterior end of body with sclerotized areas on both sides of anal lobes and on ventral surface at margin of some preceding segments.

DESCRIPTION OF IMMATURE INSTARS. Body oval but head angular in first instar and becoming more rounded in successive instars. Prothorax with a slight constriction in first instar but constriction increasingly apparent in second and third instars. Sclerotization on head starting around eyes in first instar and increasing in each instar to around base of antenna and in an area forward from clypeus. Anal lobes always developed to some extent. Antenna 6-segmented, often as long as body. In the first instar long pointed setae form whorls usually at distal end of segments but in the second and third instars the segments become densely covered with short pointed setae. Legs well developed, claw stout, with 2 flat, wide digitules even in the first instar. Labium with 14 basic pairs of setae but this number often increasing in third instar. Ostioles similar in shape to those of adult but without setae. Anal ring usually narrow with a few minute pores. Setae about as long as body on anal lobes and on at least first segment preceding lobes, often present as far forward as second segment or sixth preceding lobes, always on sclerotized areas. Body setae long on first instar but second and third instars with increasing numbers of short setae. In some species there are numerous minute setae with the seta shorter than diameter of setal base. Trilocular pores and simple pores present only except in second instar male which has multilocular disc pores and oral collar tubular ducts also.

DISCUSSION. The genus is probably more closely related to *Allomyrmococcus* than to any other, differing mainly in the sclerotized head, the presence of a circulus and the terminal anal ring.

DISTRIBUTION. Malaya and the Riouw Is in Indonesia. A third instar female of an undescribed species is known among material of *Allomyrmococcus acariformis* collected by Takahashi in Thailand. See also the record from Sarawak on p. 6.

Key to species of *Malaicoccus* (adult females)

- 1 A distinct tuft of short slender setae opposite each first spiracle, the space between these setal bases shorter than the length of a seta 2
- Tuft of short setae opposite each first spiracle absent *formicarii* Takahashi (p. 33)
- 2 Setae in median area of ventral thorax all short and slender except for an occasional long seta *khooi* sp. n. (p. 39)
- Setae in median area of ventral thorax with numerous long stout setae in addition to short slender setae 3
- 3 Long marginal setae each nearly 1.0 mm long on last 4 segments. Long setae in median areas of anterior ventral abdominal segments absent *moundi* sp. n. (p. 44)
- Long marginal setae nearly 1.0 mm long on last 2 segments only. Marginal setae on preceding segments much shorter. Long setae present in median areas of all abdominal segments 4
- 4 Hind tibia with setae 40–60 μ m long, the spaces between setal bases often longer than a seta. A seta 80 μ m long on seventh segment in addition to long setae on eighth segment and anal lobes *takahashii* sp. n. (p. 52)

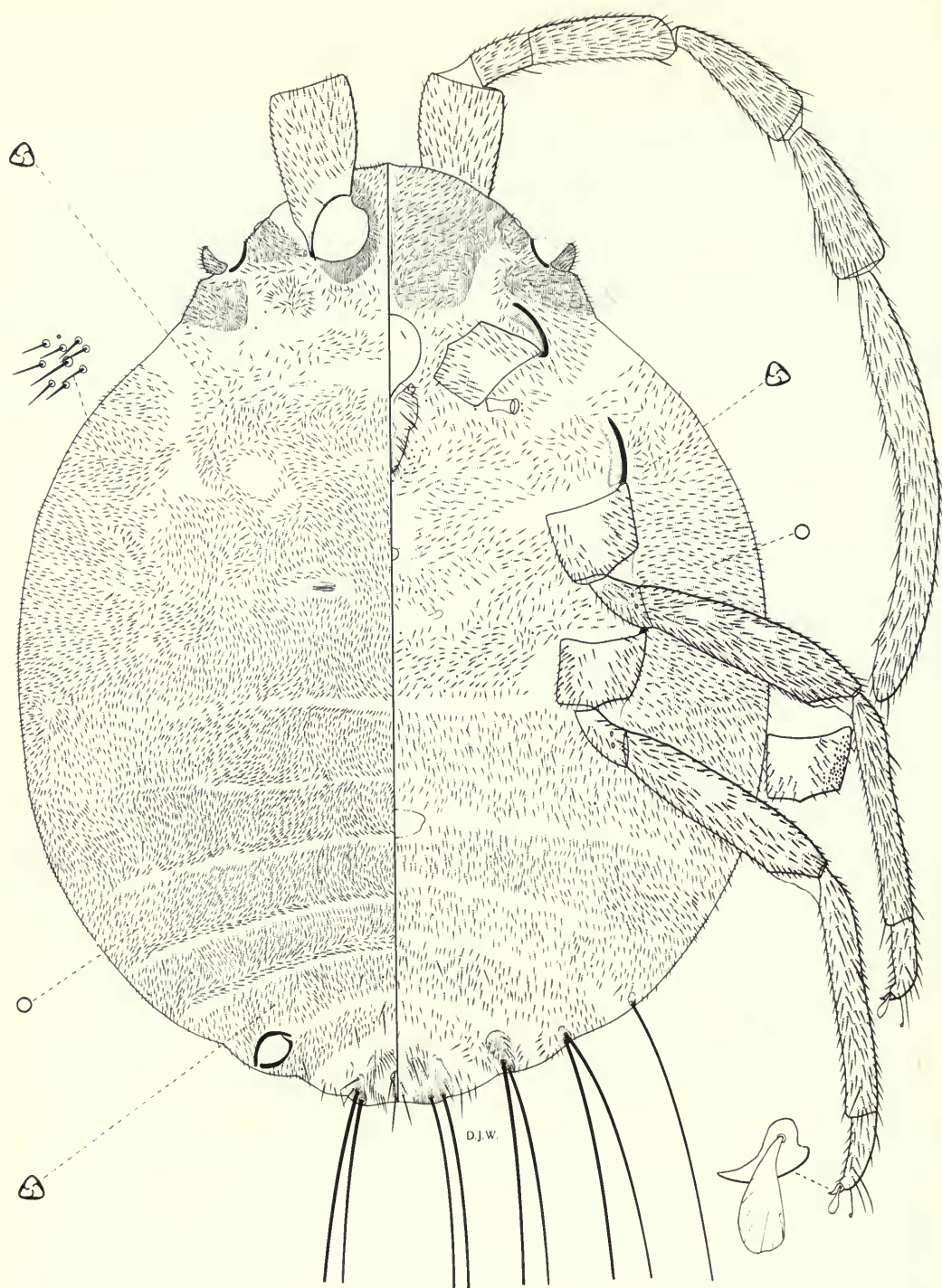


Fig. 12 *Malaicoccus formicarii* Takahashi. Adult female. Specimen from Malaya, Fraser's Hill.

- Hind tibia with numerous setae about 28 μm long, the spaces between setal bases shorter than a seta. Single setae 200–400 μm long on margins of sixth and seventh segments in addition to long setae on eighth segment and anal lobes *riouwensis* Takahashi (p. 50)

Immature Instars

It is hoped that the immature instars described here may be recognized easily from the illustrations and descriptions but in the absence of suitable material of some species it is not possible to present a workable key. Some of the following distinguishing characters may prove useful. In *M. takahashii* there are long setae on the anal lobes and margins of the eighth abdominal segment only but in the other species studied, long marginal setae reach as far forward as the second abdominal segment or sixth preceding segment from anal lobes. *M. khooi*, *M. mouni* and *M. takahashii* have unusually short setae in the second and third instars, each seta much shorter than the diameter of the setal bases. The characters of the adult female are reflected in the immature instars. For instance, in *M. khooi* there is a short wide terminal segment on the antenna in the adult, third and second instars and there is an absence of long setae on the ventral surface of thorax in the adult and third instars. The labium of the first and second instars has the basic number of 14 pairs of setae. In *M. mouni* this number persists in the third instar but in the other species studied the number increases to as many as 18 pairs in the third instar. The labium of the second and third instars of *M. khooi* has a primary medial seta which is clavate and digitule-like. Second instar males are easy to recognize by the multilocular disc pores and oral collar tubular ducts on both surfaces.

Malaicoccus formicarii Takahashi, 1951

Malaicoccus formicarii Takahashi, 1951 : 5. LECTOTYPE ♀, WEST MALAYSIA: Malaya, Fraser's Hill, 6.vi.1943 (*R. Takahashi*) (BMNH, London), here designated [examined].

Adult Female (Fig. 12)

External appearance described as 'brownish black, without wax'.

On the slide body quite rotund except for a constriction on prothorax. Head and thorax heavily sclerotized around bases of antennae, in a broad band posterior to first pair of ostioles and ventrally in an area forward from clypeus to margins, there being a separate area running from the dorsal to ventral surface enclosing eye. The extent of the sclerotization varies slightly in different specimens. Antennae 2.3–2.5 mm long, the second segment longer than wide and all segments densely covered with slender setae which become longer towards apical segment. In an antenna 2.45 mm long the first segment is 300 μm long, second 140 μm , third 320 μm , fourth 340 μm , fifth 370 μm and sixth 950 μm , the last segment strongly curved. Legs well developed, hind trochanter+femur 610–670 μm long, hind tibia+tarsus 670–760 μm long, always longer than trochanter+femur. Hind coxae with translucent pores towards outer edge. All segments densely covered with short setae. Claw 48 μm long. Circulus 150 μm wide, wider than long with a constriction on either side. Anal ring elongate and becoming quite narrow at the point of constriction, easily distorted, with a few minute pores. Ostioles well developed, the anterior pair each with a narrow sclerotized lip which is apparently fixed, the posterior lip in the form of a hinged plate containing short setae which, when not flat against anterior lip, opens to almost right-angles to body. Posterior pair similar but posterior lip narrower, with a few setae. Labium 210 μm long and 120 μm wide, with 23–30 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, 1 pair of lateral setae each 72 μm long, 3–7 pairs of anterior setae, the longest 60 μm . Medial segment with 9–12 pairs of setae, the longest 72 μm long. Basal segment with a pair of short setae each 24 μm long and a pair each 32 μm long. Body setae all pointed. Long marginal setae in four distinct groups on either side of abdomen, all about 1.0 mm long. Anal lobe setae comprising a pair on dorsal surface on a small triangular area of sclerotization and a ventral pair on a larger subrectangular sclerotized area. A pair of long setae also present on ventral margin of eighth segment at base of large sclerotized area. A pair also located on margin of seventh segment and a single seta on margin of sixth segment. Dorsal setae abundant, covering most of surface except parts of thorax and head where there are naked areas. The setae lie in definite waves or directions on each segment, a common length being about 16 μm except for longer setae on posterior abdominal segments and on two sclerotized crescentic areas anterior-lateral to anal ring. Ventral setae also abundant but not so numerous as on dorsum, mainly 20 μm long. Trilocular pores very few on both surfaces except for a noticeable concentration near inner edge of first coxa and around the labium. A few minute circular pores also present, each with a diameter much smaller than a trilocular pore or setal base. Tubular ducts absent.

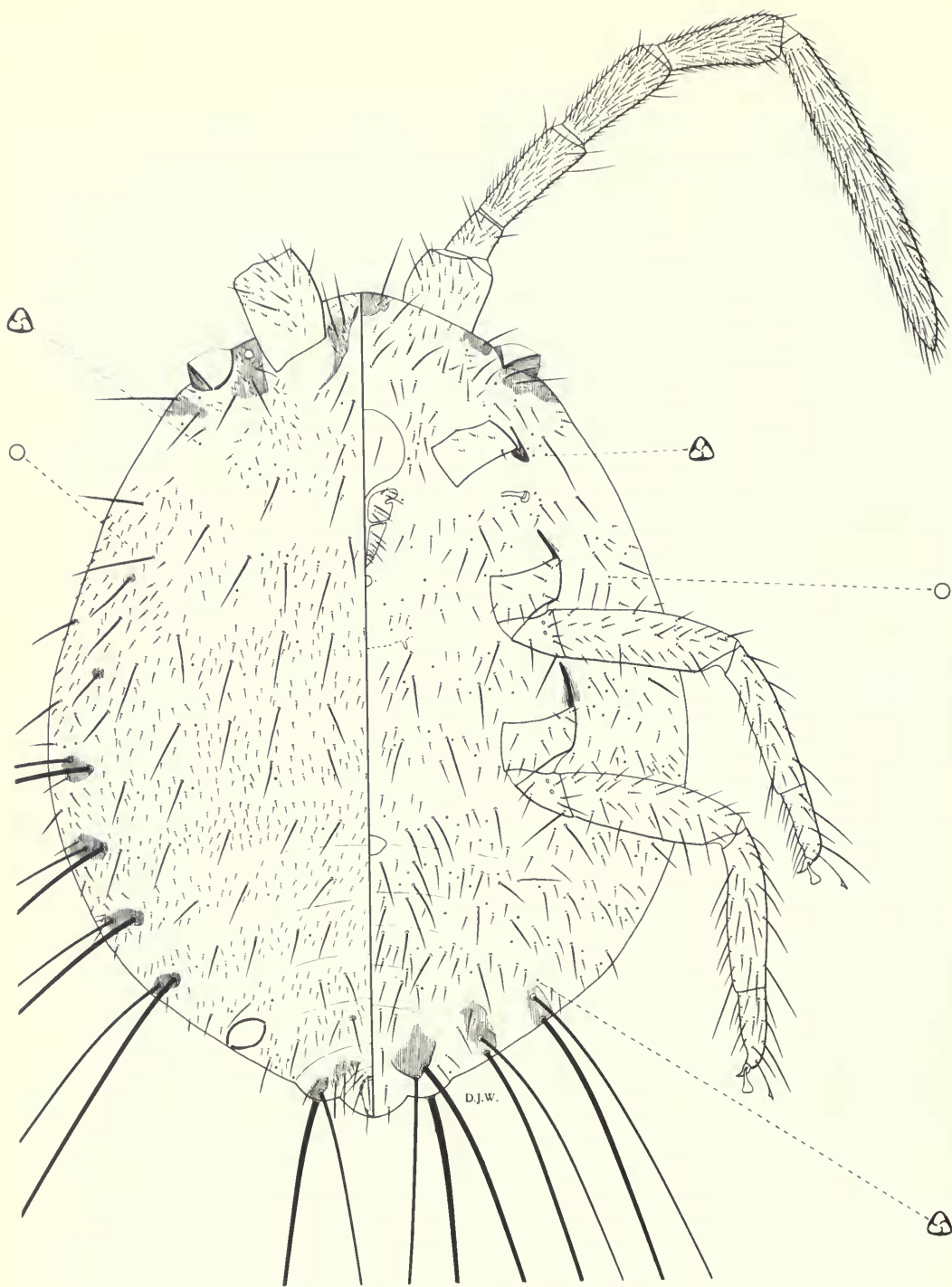


Fig. 13 *Malaicoccus formicarii* Takahashi. Third instar female.

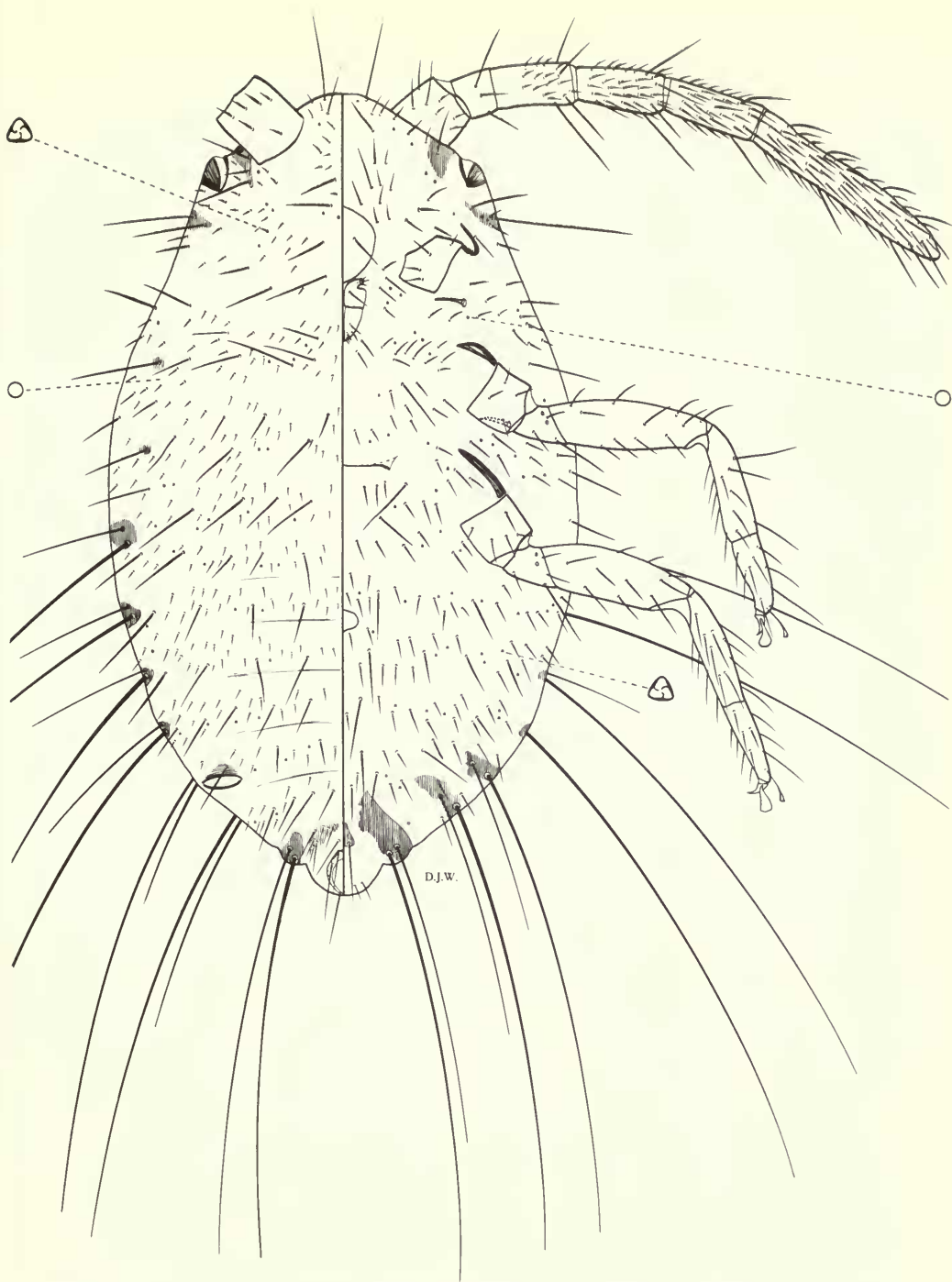


Fig. 14 *Malaicoccus formicarii* Takahashi. Second instar female. Specimen from Selangor, Ula Langat.

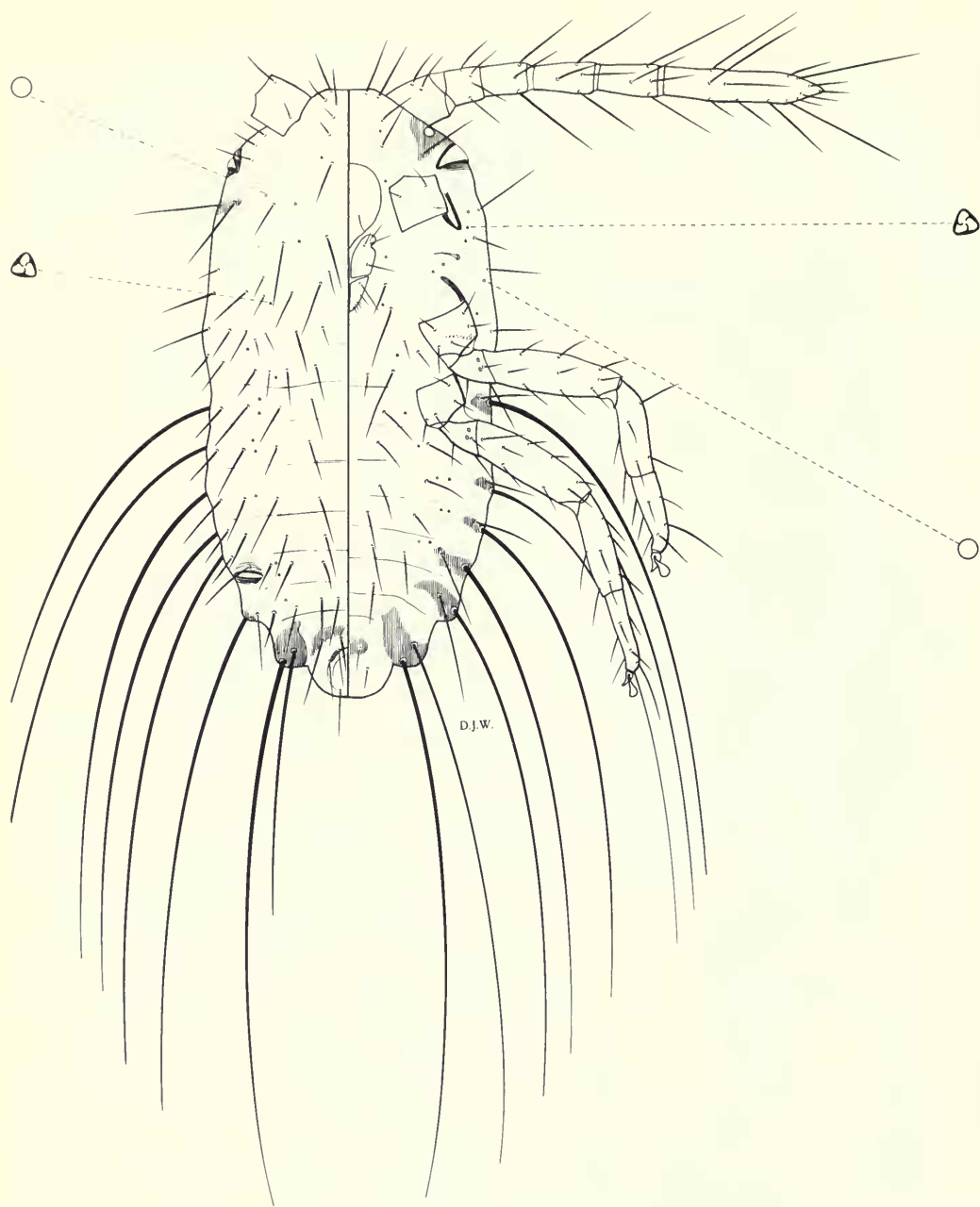


Fig. 15 *Malaicoccus formicarii* Takahashi. First instar.

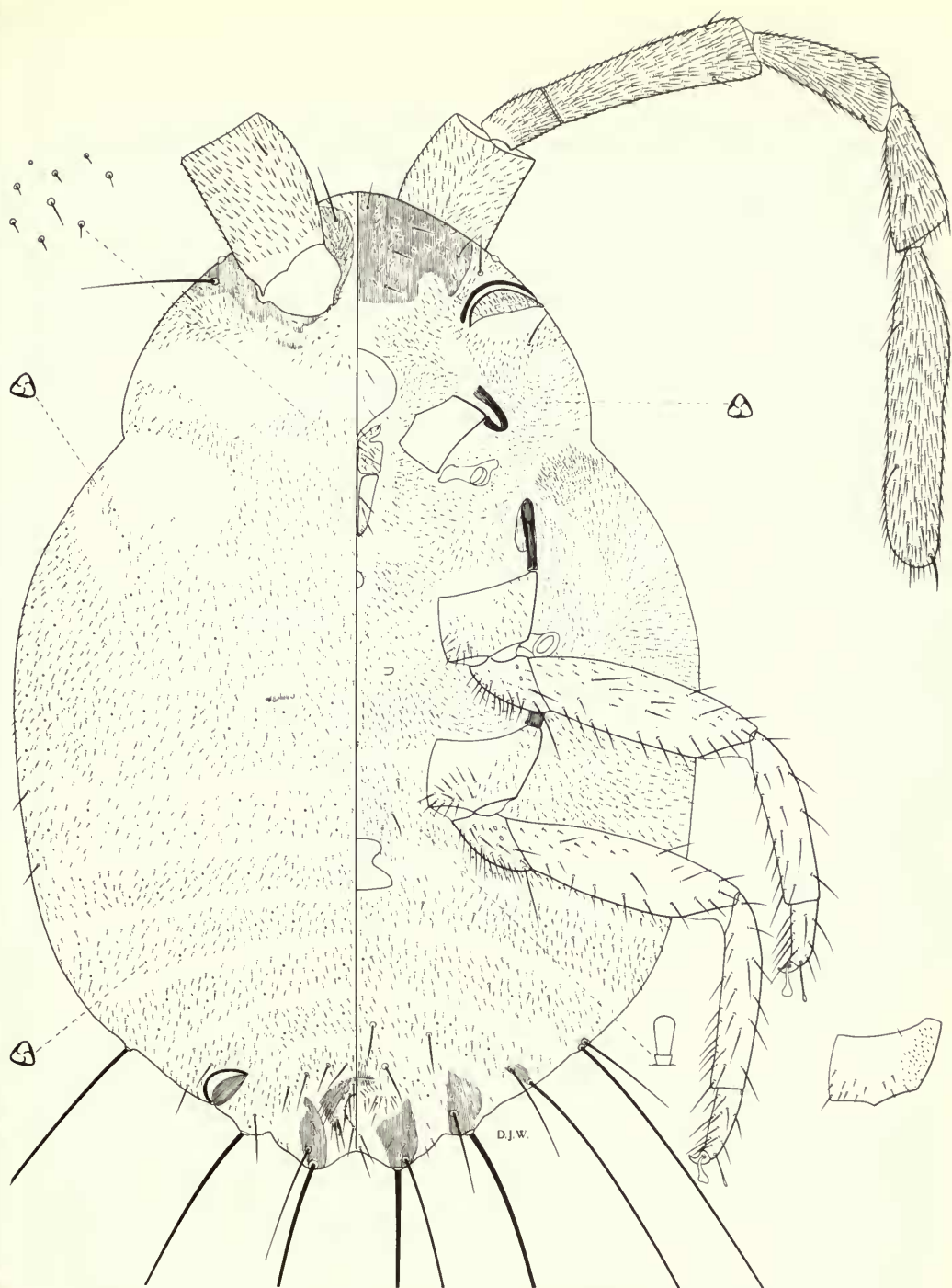


Fig. 16 *Malaicoccus khooi* sp. n. Adult female. Specimen from Malaya, Genting Highlands, on *Poikilospermum cordifolium*.

Third Instar Female (Fig. 13)

This instar has many of the features of the adult female but the body is less broadly oval, 1.75 mm long and 1.2 mm wide and with a smaller constriction opposite first coxae. Antennae 1.70–1.75 mm long, the first two segments with numerous short setae and the third to sixth segments densely covered with slender setae. Long marginal setae on abdomen numbering 6 pairs, about 1.0 mm long on irregular sclerotized areas. Short body setae less numerous than in previous stage, the dorsal setae 20–28 μm long and some of the ventral slightly longer. Other body setae present much longer than the dorsal, ranging from 60 to 150 μm long and ventral setae distributed across the segments 60–180 μm long. Sclerotization not so extensive as in adult. In addition to areas around marginal setae and behind the antennae there is a distinctive sclerotized area just below first pair of ostioles, and two triangular areas between antennal bases on dorsum, these containing setae. Circulus about 88 μm wide with a constriction on either side. Trilocular pores and smaller simple pores present but few. Anal ring narrow with lateral constrictions and becoming distorted during the preparation of the insect on the slide, with a few minute pores. Legs with a few short setae and some long pointed setae, hind trochanter+femur 430–450 μm long, hind tibia+tarsus 500–510 μm long. Claw 44 μm long. Labium 160 μm long and 100 μm wide, with 17–18 pairs of setae. Apical segment with 4 pairs of subapical setae each 28 μm long, a pair of slender lateral setae each 36 μm long and 2–3 pairs anterior setae, the longest 68 μm . Medial segment with 3–4 pairs, the longest 68 μm long, basal segment with 2 pairs basal setae each 24 μm long and a pair each 60 μm long.

Second Instar Female (Fig. 14)

Body oval, about 1.35 mm long and 0.8 mm wide, with anterior end angled and with slight constrictions on the thorax opposite the first coxae. Antennae about 1.0 mm long, with long pointed setae and with a few short slender setae on first segment and numerous such setae on third to sixth segments. Legs with hind trochanter+femur 320 μm long, hind tibia+tarsus 350 μm long. Claw about 36 μm long. Labium 130 μm long and 80 μm wide with 14 pairs of setae. Apical segment with subapical setae each 24 μm long, a pair of slender lateral setae each 32 μm long and 2 pairs of anterior setae, the longest 72 μm long. Medial segment with a single pair of medial setae each 56 μm long and basal segment with 3 pairs of setae, a long pair each 52 μm long and 2 shorter pairs each 20 μm long. Anal ring sclerotized with 6 setae about 80 μm long, with a few minute pores at anterior end and one or two only at sides. Circulus 64 μm wide, oval with a slight notch on either side. Marginal setae on abdomen reaching over 1.0 mm in length. On the anal lobes there are 2 dorsal and 2 ventral setae, the dorsal setae on an irregular-shaped area of sclerotization and the ventral pair on a larger area that extends inwards over most of segment. The anterior long marginal setae either on venter or dorsum when mounted on slide depending on convexity of body. Each long seta accompanied with a much shorter seta, their bases on an irregular-shaped sclerotized area. Other sclerotized areas at bases of shorter setae on thorax, behind the antennae and on either side of anterior end of anal ring, the latter areas crescentic or triangular containing a few setae. Other body setae less numerous than in third stage, thick pointed setae present up to 120 μm long, also short pointed setae which on dorsum are 16–20 μm long and on venter about 40 μm long. Ostioles well developed, the anterior pair with a movable hinged lip.

First Instar (Fig. 15)

Body oval, about 1.05 mm long and 0.6 mm wide. Anal lobes poorly developed, anal ring on apex of abdomen, projecting further than anal lobes. Anal lobes with 2 ventral apical setae about 1.1 mm long, 1 dorsal seta about same length and another about half the length. The five preceding segments each with marginal ventral setae, these also about 1.0 mm long, all of these setae including those on anal lobes, on irregular-shaped sclerotized areas which, anterior to anal lobes, also contain a much shorter seta. Sclerotized areas present on head around the eyes and in a crescentic patch on either side of anal ring. Antennae 620 μm long, with long pointed setae only on each segment. Ostioles prominent with heavily sclerotized lips. Circulus apparently absent. Anal ring sclerotized with 6 setae each about 44 μm long and a few minute pores at anterior edge only. Legs well developed, hind trochanter+femur 220 μm long, hind tibia+tarsus 260 μm long. Labium 110 μm long and 70 μm wide with 14 pairs of setae. Subapical setae each 20 μm long, a single pair of lateral setae each 40 μm long and 2 pairs of anterior setae the longest 60 μm long. Medial setae present as a single pair each 64 μm long. Basal segment with 2 pairs of setae each 20 μm long and a pair 44 μm long. Trilocular pores and simple circular pores in submedian areas, quite sparse.

MATERIAL EXAMINED. *Malaicoccus formicarii* Takahashi, lectotype ♀, WEST MALAYSIA: Malaya, Fraser's Hill, 6.vi.1943 (*R. Takahashi*) (BMNH, London).

WEST MALAYSIA: 17 ♀ and immatures, same data as lectotype (BMNH, London); 7 ♀, Selangor, Kepong, on *Bauhinia* sp. [Leguminosae], 29.viii.1943 (*R. Takahashi*); 2 ♀ and immatures, Selangor, Ula Langat, on 'jungle plant', 1928 (*H. T. Pagden*); immatures, Fraser's Hill, on *Languas* sp. [= *Alpinia*] [Zinziberaceae], 6.vi.1943 (*R. Takahashi*) (BMNH, London); 3 ♀, Cameron Highlands, on *Rubus* sp. [Rosaceae], x.1944 (*R. Takahashi*) (UM, Kuala Lumpur); 2 ♀ and immatures, Gombak, on *Mikania scandens* [Compositae], 4.xi.1971 (*Y. P. Tho*) (UM, Kuala Lumpur).

DISCUSSION. The adult female is unlike any other in the genus in lacking a tuft of short setae on the venter opposite the first spiracles and in having the short body setae so densely covered that the distance between setal bases is shorter than the length of a seta.

Malaicoccus khooi sp. n.

Adult Female (Fig. 16)

External appearance not known. Body broadly oval, about 2.35 mm long and 2.17 mm wide with a deep constriction opposite first coxae. Head heavily sclerotized around antennal bases on dorsum and encircling the eyes, this area continuing to ventral surface just above anterior ostioles. Ventral head region anterior to clypeus almost completely sclerotized. Antennae about 1.88 mm long, first segment 250 µm, second 130 µm, third 360 µm, fourth 300 µm, fifth 260 µm and sixth 560 µm long, the last segment rather short and squat compared with that in other species. All segments densely covered with slender setae. Labium 208 µm long and 108 µm wide with 27 pairs of pointed setae. Apical segment with a pair of posterior setae, a pair of minute apical setae about 4 µm long, 4 pairs of subapical setae each 32 µm long, a pair of lateral setae 52 µm long and 2 pairs of anterior setae, the longest 72 µm. Medial segment with 11 pairs of setae, the longest 64 µm long. Basal segment with 3 pairs of setae, the basal pair 16 µm long and the longest 56 µm. Circulus rather large with a deep constriction at either side, about 230 µm at its widest at posterior end. Legs stout, well developed, hind trochanter+femur 520 µm long, hind tibia+tarsus 460 µm long and thus shorter than trochanter+femur. Hind coxa with a few translucent pores on outer dorsal surface, short setae on outer ventral surface and longer pointed setae on inner ventral surface. Long setae also present on outer margin of trochanter and a few present on femur, tibia and tarsus: a few short setae also present on proximal end of femur. Claw 40 µm long. Anal ring reduced to a narrow rim with 6 setae each about 64 µm long, and a few minute pores. Ostioles well developed, the anterior pair lying on ventral surface when mounted on the slide due to convexity of body. Both pairs with edge of anterior lip heavily sclerotized and probably fixed, the posterior lips forming a hinged semi-circular plate which is capable of folding over to anterior lip, this plate with numerous short setae on anterior ostioles but without setae in posterior pair.

Marginal setae on abdomen long, on anal lobes and three preceding segments. Anal lobes with 1 long dorsal and 2 long ventral setae each 850 µm long, the dorsal surface also with a shorter seta about one-third length on an elongate-oval area of sclerotization. Ventral anal lobe setae at apex of a subrectangular sclerotized area. Marginal setae on three preceding segments slightly ventral in position. Eighth segment with a single seta 950 µm long and a much shorter seta on a subrectangular area of sclerotization. Seventh segment with a seta 480–550 µm long and a shorter seta on a small sclerotized patch. Sixth segment with a seta 490–600 µm long and also a short seta on a small sclerotized patch. Dorsal surface of head lateral to each antennal base with a long pointed seta about 32 µm long. A few other setae 12–18 µm long also within the sclerotized areas of head, on abdominal margins and in mid-regions of eighth segment on dorsum and seventh and eighth segments on venter. A few setae present on a sclerotized crescentic area on either side of anal ring. Other body setae numerous, ranging from 8 to 16 µm long on dorsum, the larger setae easily noticeable by the larger setal bases, evenly distributed except on head and thorax where there are a few completely bare areas. Ventral body setae usually longer than dorsal, 12–20 µm long, the longer setae being the most numerous. A distinct tuft of short setae present near margin opposite each first spiracle. Trilocular pores not numerous, evenly distributed but a few concentrated near labium. Minute circular pores sparse, each with a diameter less than a setal base. Tubular ducts each with a diameter smaller than a trilocular pore, represented by one or two on inner side of second and third coxae.

Third Instar Female (Fig. 17)

Body similar in shape to that of adult female with deep constriction opposite first pair of coxae, 1.4 mm long and 0.9 mm wide. Antennae 1.25–1.30 mm long, the longest with first segment 180 µm long and 160 µm wide, second 90 µm long, third 260 µm, fourth 230 µm, fifth 200 µm and sixth 430 µm. All seg-

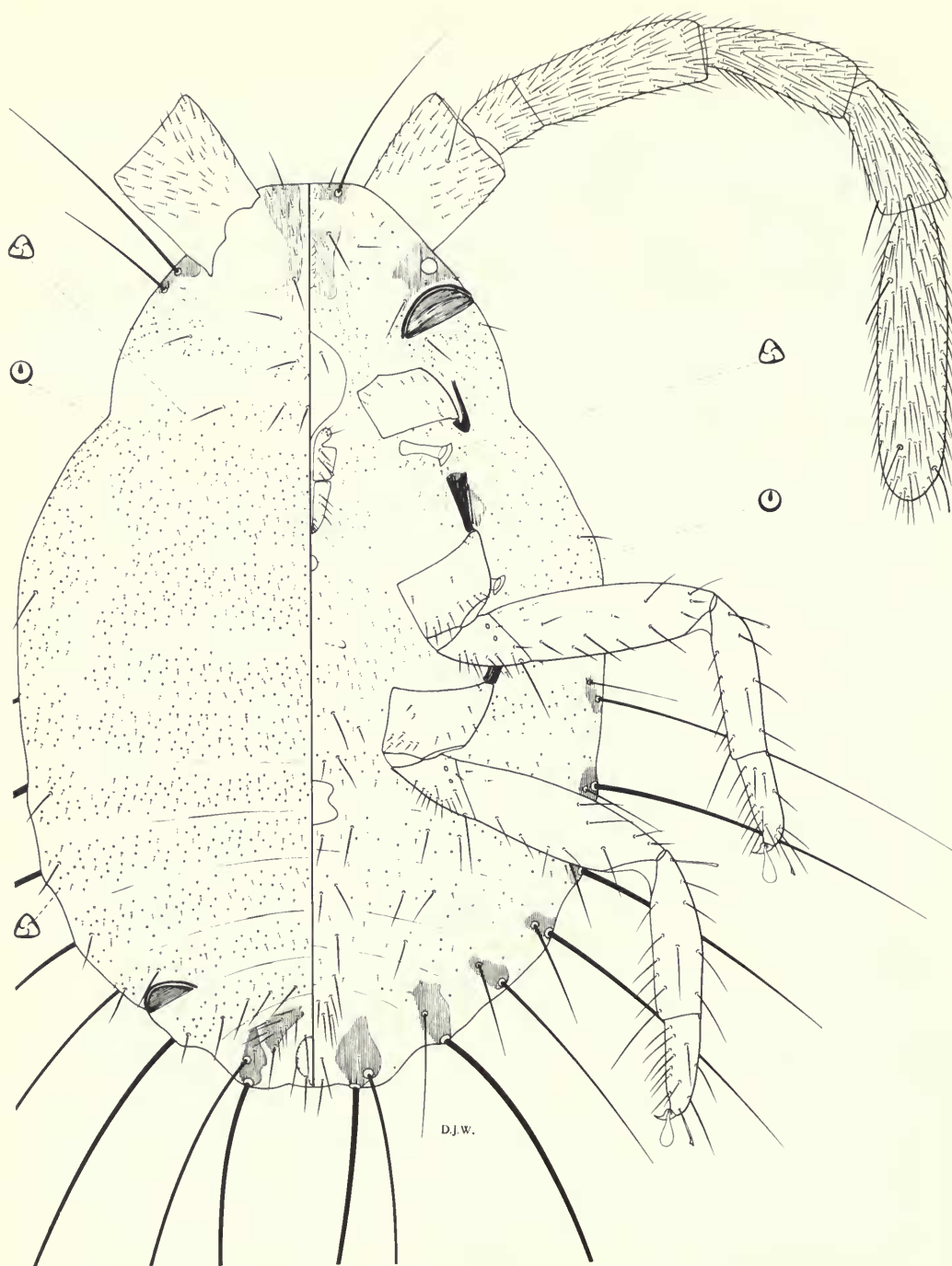


Fig. 17 *Malaicoccus khooi* sp. n. Third instar female.

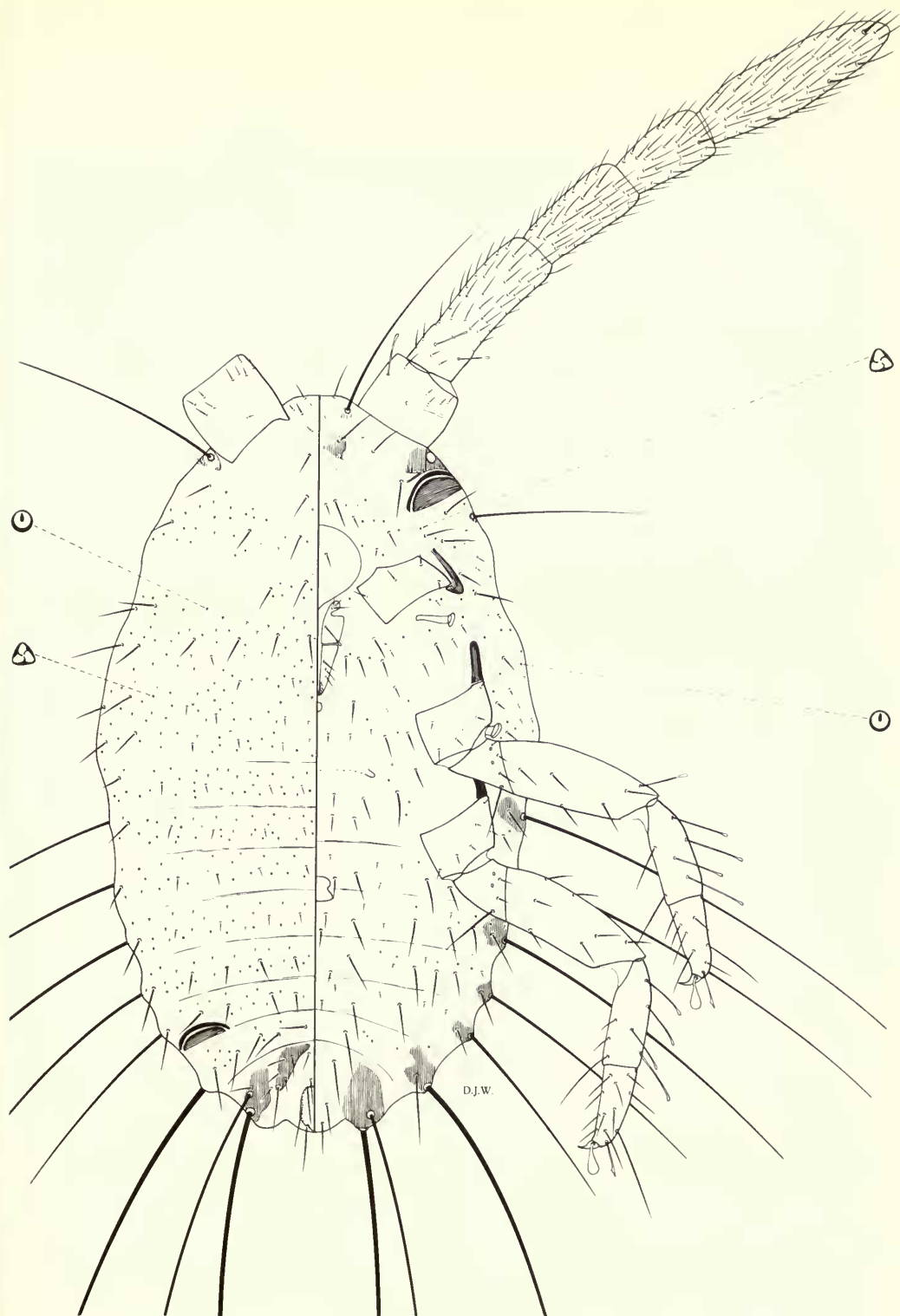


Fig. 18 *Malaicoccus khooi* sp. n. Second instar female.

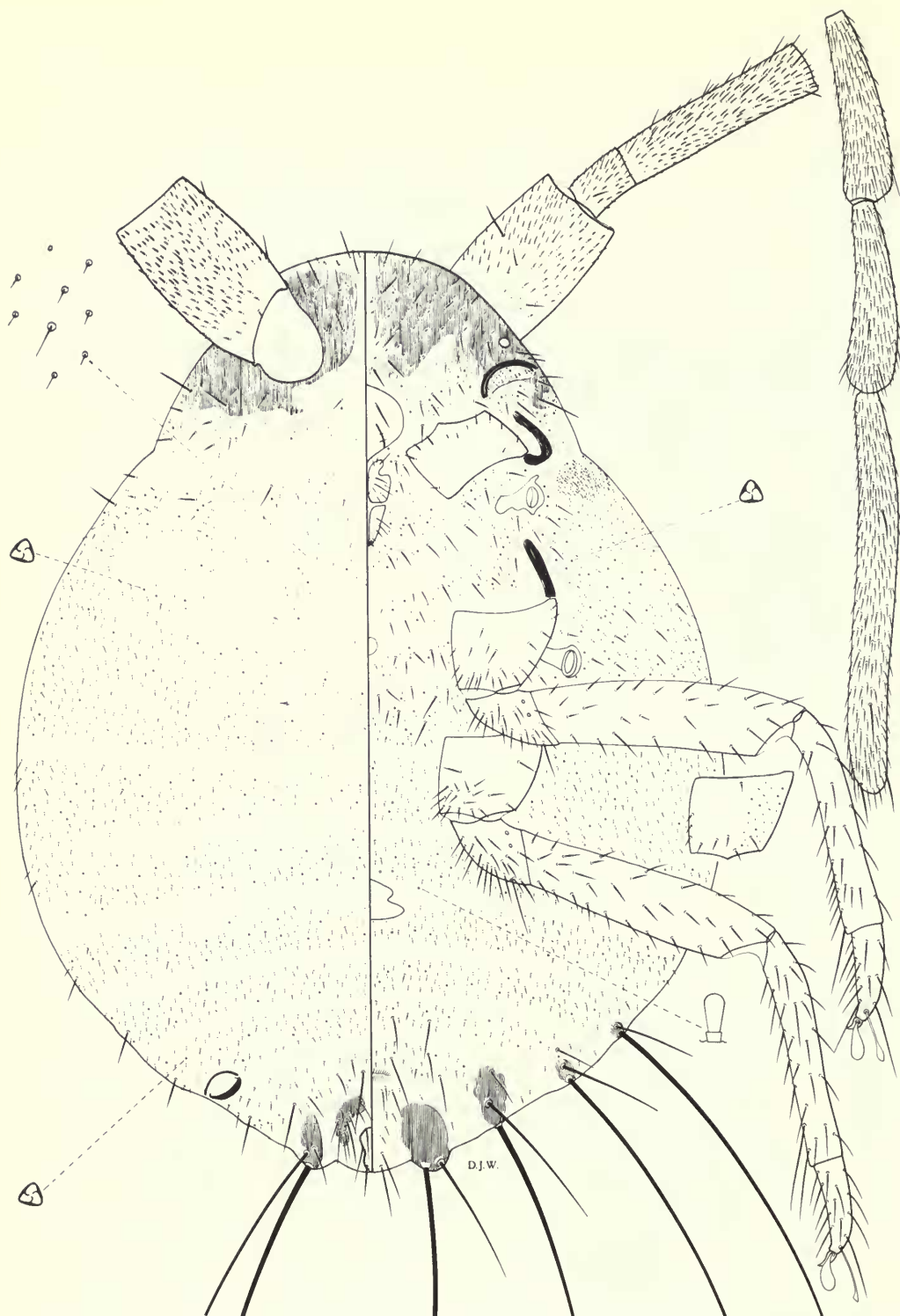


Fig. 19 *Malaicoccus moundi* sp. n. Adult female. Specimen from Malaya, Genting Highlands, on stems of *Uncaria* sp.

ments densely covered with slender setae ranging in length from 30 to 40 μm on first segment to 45 μm on last segment. Legs well developed, stout. Hind trochanter + femur 390–400 μm long, hind tibia + tarsus 360–370 μm long. All legs with pointed setae of different sizes but second and hind legs each with a pair of knobbed digitule-like setae on outer proximal end of tibia, the first legs with similar setae at distal end of femur and along outer edge of tibia. Labium 160 μm long and 100 μm wide, with 17 pairs of setae. Apical segment with a pair of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae each 24 μm long, 1 pair of lateral setae each 44 μm long, 2 pairs of anterior setae the longest 68 μm long. Medial segment with 4 pairs of setae, one of the pairs knobbed and digitule-like, 48 μm long. Basal segment with 2 pairs 16 μm long and 1 pair 52 μm long. Circulus constricted, widest at posterior end, 120 μm wide. Anal ring slender with a few minute pores and 6 setae each 64 μm long. Ostioles as in adult female, the anterior pair lying on ventral surface when mounted on slide but these ostioles without setae. Anal lobes sclerotized on both surfaces. Dorsal surface of each lobe with a seta 0.85 mm long and a shorter 330 μm long. Ventral surface of lobe with apical seta 0.85 mm long and another probably shorter but broken in available specimens. Stout marginal setae on 6 anterior segments. On the eighth segment these setae are 0.85 mm long, on the seventh 350 μm , sixth 450 μm , fifth 450 μm , fourth 500 μm and third 550 μm long.

Dorsal surface with setae of different sizes. A pair of stout marginal setae each 350 μm long present just behind first antennal segment. Other setae about 50–60 μm long, few on prothorax, head and last two abdominal segments and singly on margins of most segments. On last segments they are present on two crescentic sclerotized areas anterior-lateral to anal ring. Short slender setae numerous, each 6–8 μm long. Minute setae abundant, each with seta much shorter than setal base. Ventral setae of similar sizes to those on dorsum but a pair 300 μm long on head margin. Other long setae, the longest of which are 85 μm , present in transverse rows on abdomen, head and prothorax. Slender setae 4–12 μm long, few on abdomen but numerous in median areas of head and thorax. Minute setae present in moderate numbers, each much shorter than setal base. Trilocular pores and simple circular pores not numerous, scattered.

Second Instar Female (Fig. 18)

Body oval, about 1.0 mm long and 0.6 mm wide, sclerotized on head around eyes and on a few setal bases. Antennae 840–880 μm long. On longest antenna first segment 110 μm long, second 60 μm , third 160 μm , fourth 150 μm , fifth 120 μm and sixth 280 μm . Slender setae numerous but on each of first and second segments there are one or two knobbed digitule-like setae. Legs well developed with hind trochanter + femur 270–280 μm long, hind tibia + tarsus 270 μm long. Knobbed setae present at distal end of first and second femora and on outer edge of all tibiae. Other leg setae all pointed except for tarsal digitules. Claw stout 28 μm long. Labium 120 μm long and 80 μm wide, with 14 pairs of setae. Apical segment with minute pair of apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae each 32 μm long and 2 pairs of anterior setae, the longest 56 μm long. Medial segment with 1 pair of knobbed setae 52 μm long. Basal segment with 2 pairs of short setae 12 μm long and 1 pair 36 μm long. Circulus constricted, 68 μm wide. Ostioles rather large for size of body, the anterior pair lying behind eye on ventral surface when mounted on slide, without setae. Anal lobes sclerotized, each with a dorsal seta 0.8 mm long, another 270 μm long and a ventral apical seta 0.8 mm long with another 450 μm long. Anterior six segments with long marginal setae, the bases surrounded by sclerotized areas. Eighth segment with marginal setae 0.8 mm long, seventh 250 μm , sixth 350 μm , fifth 490 μm , fourth 550 μm and third 550 μm long. Anal ring with a few minute pores and 6 setae each 60 μm long.

Dorsal surface with stout setae on thorax and posterior abdominal segments 24–50 μm long. On remainder of abdomen the setae are small and slender, about 12 μm long. A pair of long setae behind first antennal segment each about 210 μm long, the area about the setal bases sclerotized. Minute setae numerous, each with seta much shorter than diameter of setal base. Ventral setae of different sizes, the longest about 50 μm accompanied with short slender setae and a few of the minute type. Trilocular pores and simple circular pores sparse.

Holotype ♀, WEST MALAYSIA: Malaya, Genting Highlands, on *Poikilospermum cordifolium* [Urticaceae], attended by ant *Hypoclinea* sp., 4.x.1973 (*L. A. Mound*) (BMNH, London).

Paratypes. WEST MALAYSIA: 3 ♀ and immatures, same data as holotype; 1 ♀, Genting Highlands, on low herbaceous plant, attended by ant *Hypoclinea* sp., 4.x.1973 (*B. Bolton*) (BMNH, London); 2 ♀, Gombak F. S., on bamboo [Gramineae], 26.x.1971 (*Khoo Soo Ghee*) (UM, Kuala Lumpur).

DISCUSSION. This species is similar to *M. moudi* in having setae about 1.0 mm long on anal lobes and margins of the three preceding segments but it differs in the setae on mid-ventral thorax

which are short and slender, rarely more than 20 μm long whereas in *M. moundsi* there are numerous setae up to 130 μm long in this area. The sixth antennal segment in *M. khooi* is about 560 μm long but in *M. moundsi* it is more slender and 710 μm long.

Malaicoccus moundsi sp. n.

Adult Female (Fig. 19)

Body broadly oval, with a distinct constriction on margins opposite first coxae, about 1.75 mm long and 1.15 mm wide. Head sclerotized around antennal bases on dorsal surface and over entire apex of venter as far as clypeus and almost to constriction on margin. Antennae densely covered with short setae which become longer towards last segment. Total length of antennae 2.12 mm and longer than body in available specimen; first segment 260 μm long, second 120 μm , third 370 μm , fourth and fifth each 330 μm and sixth segment 710 μm long. Legs well developed, hind trochanter+femur 640 μm long, hind tibia+tarsus 630 μm long hence slightly shorter than trochanter+femur. All segments with moderately long setae, hind coxa with a few translucent pores on dorsal outer half. Claw 56 μm long. Labium 212 μm long and 124 μm wide, with 22 pairs of pointed setae. Apical segment with 2 pairs of posterior setae, 1 pair of apical setae about 16 μm long, 4 pairs of subapical setae each about 28 μm long, 1 pair of slender lateral setae each 64 μm long and 2 pairs of anterior setae, the longest 92 μm . Medial segment with 8 pairs of setae, the longest 84 μm . Basal segment with 4 pairs of setae, the shortest 22 μm long and the longest 68 μm long. Circulus large with a deep constriction on either side, the posterior edge wider than anterior edge, 240 μm at widest. Anal ring elongate and narrow, constricted, but distorted in available specimen; with 6 setae, each 72 μm long and a row of minute pores. Ostioles well developed, each with a fixed sclerotized anterior lip and a hinged sclerotized posterior lip which may completely close the ostiole. Anterior pair on ventral margin on slide probably due to convexity of body, the posterior lips with a few setae.

Marginal setae on abdomen, on anal lobes and three preceding segments, the long setae all about 1.2 mm long. Anal lobe setae represented by 2 on dorsum, one thinner than the other, at apex of an elongate area of sclerotization. Ventrally each lobe with a pair of long setae and a large subrectangular area of sclerotization. Sixth to eighth segments with long setae on ventral margins, those on sixth segment accompanied with a shorter seta about 130 μm long, on the seventh segment with a shorter seta about 130 μm long and on the eighth segment with a seta about 400 μm long. Stout setae 50–130 μm long present dorsally on head, prothorax, abdominal margins, median areas of eighth and posterior segments and in a cluster on a sclerotized crescentic area on each side of anal ring. Similar setae present ventrally on head, in median areas of thorax and in mid-region of seventh and posterior segments of abdomen. One or two longer setae 130–300 μm long, in median area of dorsal and ventral eighth abdominal segment. Body setae abundant except on dorsum of head and prothorax where there are extensive bare areas. These setae extremely slender, 6–24 μm long, the majority being the smallest. Ventral surface opposite first spiracles with a distinctive tuft of short setae. Trilocular pores not numerous, evenly distributed but absent on head; there are, however, noticeable concentrations around labium. Simple circular pores, each with a diameter smaller than a trilocular pore, in moderate numbers between second and third coxae.

Third Instar Female (Fig. 20)

Body broadly-oval with a constriction opposite first coxae giving the body a pyriform appearance, about 1.4 mm long and 0.95 mm wide. Head sclerotized on dorsum between antennal bases, on venter between clypeus and anterior margins, and surrounding eyes. Anal lobes moderately developed. Antennae about 1.57–1.58 mm long, the first segment 170 μm long, second 100 μm , third and fourth each 250 μm , fifth 260 μm and sixth 550 μm long, each segment with numerous slender setae which on first segment are about 32 μm long and on sixth segment about 36 μm long. Legs with hind trochanter+femur 460–470 μm long, hind tibia+tarsus about 460 μm long, stout. Labium 160 μm long and 100 μm wide. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 24 μm long, 1 pair of lateral setae each 40 μm long and 2 pairs of anterior setae 60 and 80 μm long. Medial segment with 2 pairs of setae 40 and 60 μm long. Basal segment with 2 pairs of short setae each 24 μm long and a pair of longer setae each 68 μm long. Anal ring slender, easily distorted, with a few minute pores and 6 setae each 88 μm long. Circulus constricted, 130 μm wide. Ostioles as in adult female, the anterior pair often lying on ventral surface when mounted on slide but without setae. Anal lobes sclerotized on dorsal and ventral surfaces, each lobe with a dorsal and ventral seta about 1.3 mm long, a ventral seta 0.8 mm long and a dorsal 0.6 mm long. Ventral margins of third to eighth segments with sclerotized areas each containing one long and one short seta, third and fourth segments with the longer seta 0.7 mm long,

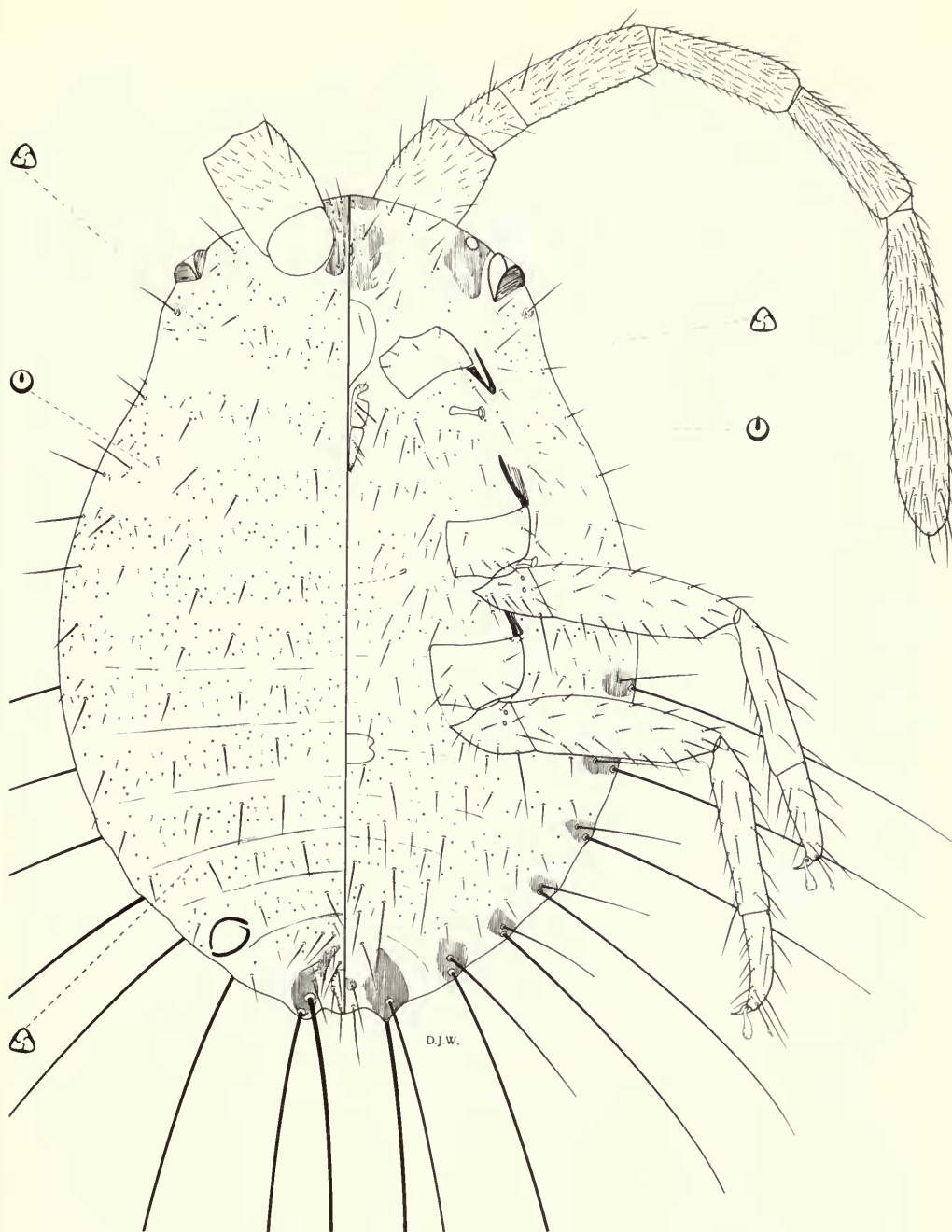


Fig. 20 *Malaicoccus moundi* sp. n. Third instar female.

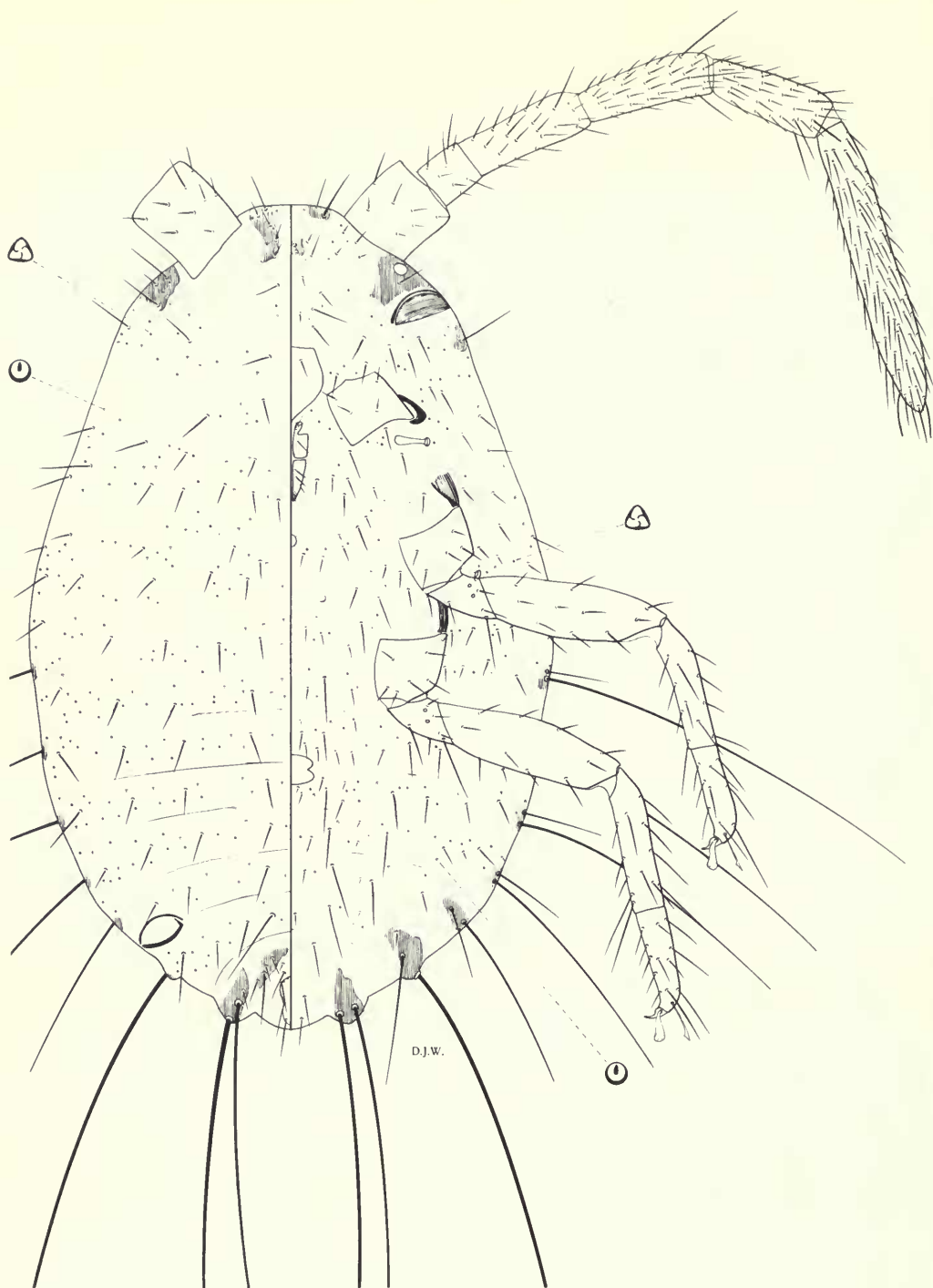


Fig. 21 *Malaicoccus moundi* sp. n. Second instar female.

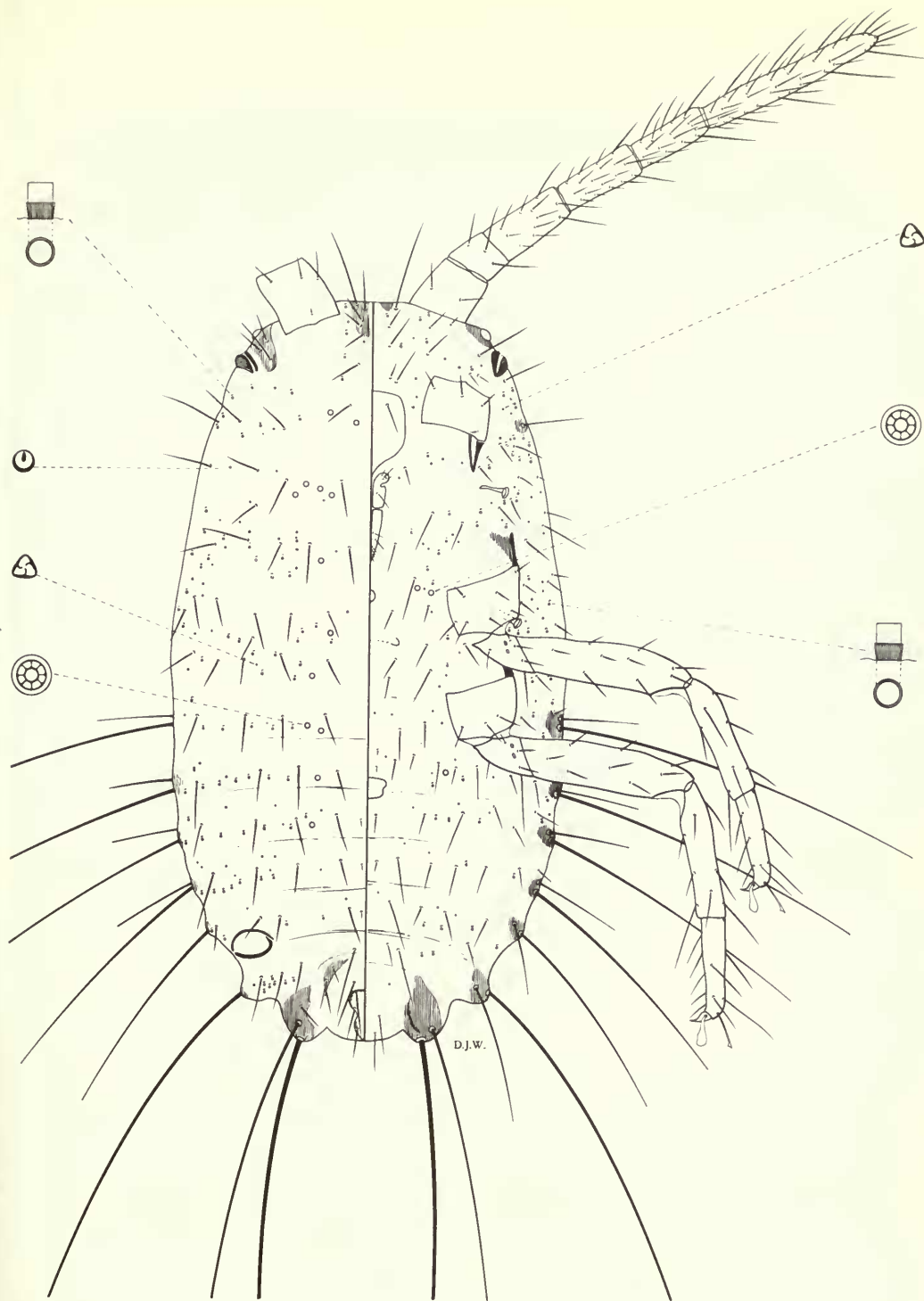


Fig. 22 *Malaicoccus moundi* sp. n. Second instar male.

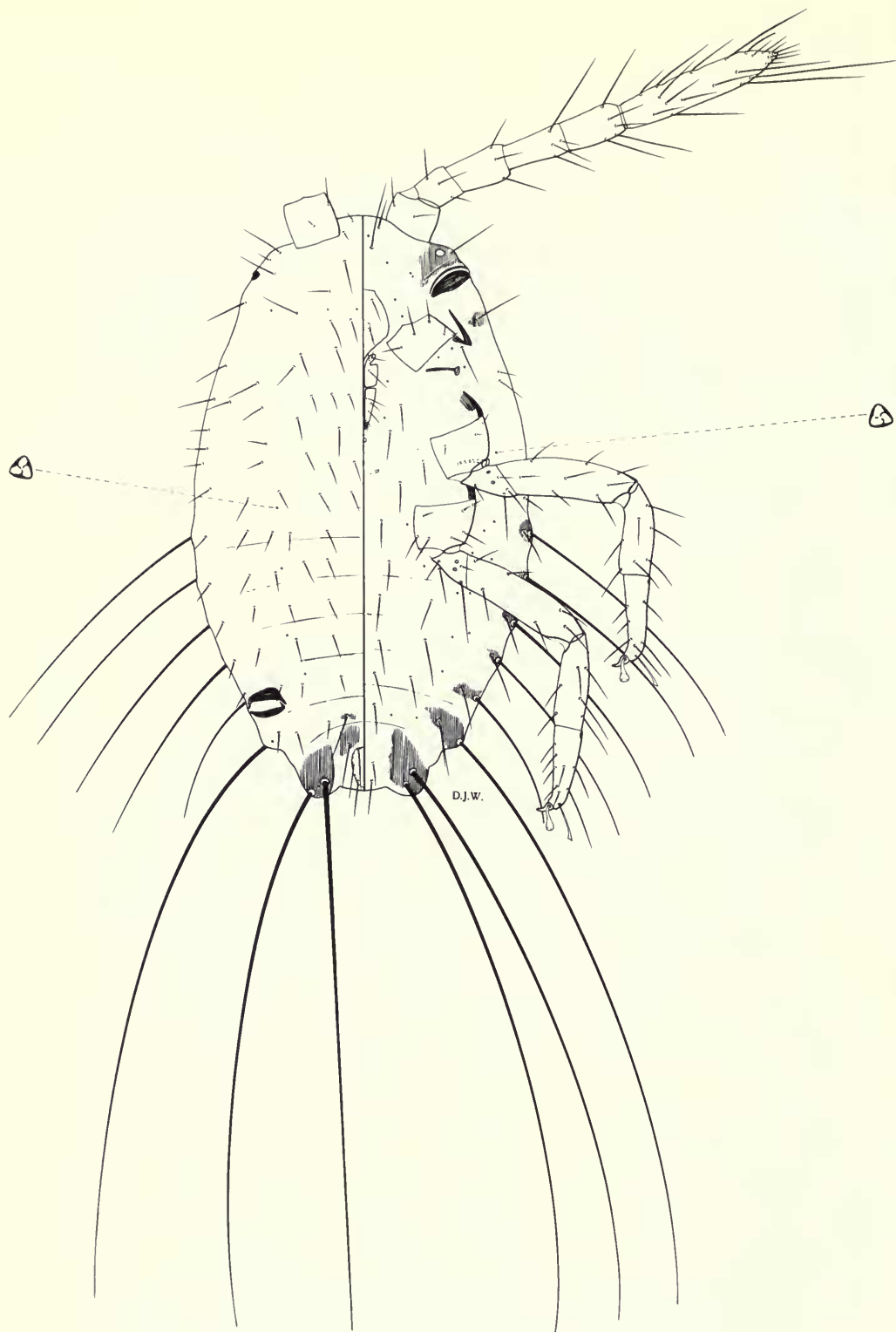


Fig. 23 *Malaicoccus moundi* sp. n. First instar.

fifth 0.6 mm, sixth 0.7 mm, seventh 0.6 mm and eighth 1.3 mm long. The short marginal seta on eighth segment about 330 μ m long, the others on anterior segments shorter.

Body setae of different sizes. Dorsum with stout setae, most about 85 μ m long, in single transverse rows but a median pair on last segment about 150 μ m long. A pair of sclerotized crescentic areas present anterior to anal ring, each with a few setae of different sizes. Stout ventral setae also of different sizes, a common length being about 100 μ m. Slender setae scattered on both surfaces, 8–28 μ m long. Other minute setae numerous, each shorter than the diameter of its setal base. Trilocular pores not numerous. Simple circular pores smaller than a trilocular pore, scattered.

Second Instar Female (Fig. 21)

This instar differs from previous instars in having shorter and fewer characters. Body about 1.25 mm long and 0.85 mm wide. Head with 2 elongate sclerotized areas between antennae on dorsum. More extensive sclerotization present around eyes and almost reaching anterior ostioles. Antennae 1.12 mm long; first segment 130 μ m long, second 60 μ m, third 180 μ m, fourth 180 μ m, fifth 170 μ m and sixth 400 μ m. All segments with numerous setae. Legs as in previous stage, hind trochanter + femur 330 μ m long, hind tibia + tarsus 350 μ m long. Claw 36 μ m long. Labium 128 μ m long and 78 μ m wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μ m long, a pair of lateral setae each 36 μ m long and 2 pairs of anterior setae 40 and 50 μ m long. Medial segment with a single pair of setae 60 μ m long. Each lobe of basal segment with a pair of short setae each 20 μ m long and 1 long seta 72 μ m long. Circulus 80 μ m wide. Ostioles as in previous stage, the anterior pair lying on ventral surface when mounted on slide, without setae. Anal ring with 1 or 2 minute pores and 6 setae each about 60 μ m long. Anal lobes each with dorsal and ventral elongate areas of sclerotization, with 2 dorsal setae, one 1.0 mm long, the other 550 μ m long and 2 ventral setae, one 1.0 mm long and the other 800 μ m long. Long marginal setae present on 6 preceding segments, each setal base surrounded by sclerotized areas. Eighth segment with seta 1.0 mm long and a shorter about 180 μ m long, seventh with seta 300 μ m long, sixth seta 370 μ m long, fifth and fourth each 500 μ m and third 630 μ m long.

Dorsum with stout pointed setae in single transverse rows, usually 44–88 μ m long except in mid-region of eighth segment where there is a pair 112 μ m long. Similar setae present in a sclerotized crescentic area anterior-lateral to anal ring. Other dorsal setae more numerous and minute, each with seta much shorter than diameter of base. Ventral surface with similar long setae to those on dorsum except on head margin where there is a pair 100 μ m long and behind first ostioles where there is a pair each about 120 μ m long, these on sclerotized bases. On abdomen there are shorter pointed setae each about 8 μ m long and minute setae of two types. One of these is similar to the dorsal minute setae but the other type is longer 2–4 μ m but always shorter or same length as setal base. Trilocular pores on both surfaces, not numerous. Simple circular pores present, sparse, smaller than trilocular pores.

Second Instar Male (Fig. 22)

Body elongate, head margin tending to be straight, 1.12 mm long and 0.65 mm wide. Antennae with 6 segments about 745 μ m long, the first segment 90 μ m long, second 45 μ m long, third 120 μ m, fourth and fifth each 110 μ m long and sixth segment 270 μ m long. Fourth to sixth segments with slender setae ranging in length from 36 to 52 μ m. Legs with hind trochanter + femur 280 μ m long, tibia + tarsus 300 μ m long. Claw 28 μ m long. Labium 120 μ m long and 68 μ m wide, with 13 or 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a minute apical pair, 4 pairs of subapical setae each 20 μ m long, a lateral pair each 36 μ m long, 1 or 2 pairs of anterior setae, the longer 64 μ m and the shorter when present 40 μ m. Medial segment with 1 pair each 60 μ m long and basal segment with 2 pairs 18 μ m long and a pair 72 μ m long. Anal ring with a few minute pores and 6 setae. Anal lobes sclerotized on both surfaces, the dorsal surface with 1 seta 0.9 mm long and another 500 μ m long, the ventral surface with one 0.9 mm long and another 650 μ m long. Long marginal setae on 6 anterior segments with bases surrounded by sclerotized areas, on eighth segment these setae 0.9 mm long, on seventh segment 220 μ m, on sixth 310 μ m, on fifth 400 μ m, on fourth 500 μ m and on third 550 μ m long.

Dorsal and ventral setae similar to those of second instar female but minute setae absent on venter and sparse on dorsum. Trilocular pores few. Simple circular pores quite sparse, each smaller than a trilocular pore. Multilocular disc pores each with 8 loculi, present on dorsum in small submedian groups on fifth abdominal segment and anterior segments to prothorax, an occasional pore also present on anterior abdominal segments and mid-thorax. Oral collar tubular ducts present, each slightly larger in diameter than a trilocular pore and only slightly longer than wide with deep sclerotized internal collar. On dorsum they tend to lie in single transverse rows but on head and thorax they become more scattered. On venter they are present mainly on head and thorax and become sparse on abdomen.

First Instar (Fig. 23)

Body oval, 1.0 mm long and 0.65 mm wide, head sclerotized around eyes. Antennae 565–700 μ m long, one of largest with first segment 80 μ m long, second 60 μ m, third 90 μ m, fourth 100 μ m, fifth 100 μ m and sixth 270 μ m long. Each segment with a few long pointed setae at distal end but more numerous setae present on last segment. Legs well developed with hind trochanter + femur 230–250 μ m long, hind tibia + tarsus 250–270 μ m long. Claw 28 μ m long. Circulus apparently absent. Labium 92 μ m long and 52 μ m wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a minute pair of apical setae, 4 pairs of subapical setae each 20 μ m long, a lateral pair 38 μ m long and 2 pairs of anterior setae 20 and 56 μ m long. Medial segment with 1 pair of setae 52 μ m long and basal segment with 2 pairs 12 μ m long and 1 pair 44 μ m long. Anal ring slender with a few minute pores and 6 setae each 52 μ m long. Anal lobes sclerotized on both surfaces, each with 2 dorsal setae, one 1.0 mm long, the other 460 μ m long and 2 ventral setae, one 1.0 mm long and the other 700 μ m long. Long marginal setae present on 6 preceding segments, the bases surrounded by sclerotized areas. All of these setae stout, measuring on eighth segment 1.0 mm long, seventh segment 160 μ m, sixth segment 220 μ m, fifth segment 280 μ m, fourth segment 280 μ m and on third segment 340 μ m.

Body setae 28–44 μ m long on dorsum but mid-region of eighth and last segment with pair of setae each 90 μ m long on sclerotized patches. Ventral setae usually longer, about 80 μ m long. Trilocular pores and simple circular pores sparse.

Holotype ♀, MALAYSIA: Malaya, Genting Highlands, 50 km E. of Kuala Lumpur, on stems of *Uncaria* sp. [Nauclaceae], attended by the ant *Hypoclinea* sp., 28.ix.1973 (*L. A. Mound*) (BMNH, London).

Not included in type-series. MALAYSIA: 2 third instar ♀, 3 second instar ♀, 3 second instar ♂ and 9 first instars, same data as holotype (BMNH, London).

DISCUSSION. The nearest species is *M. khooi* but it differs in the characters given in the discussion of that species. It differs from *M. riouwensis* and *M. takahashii* in having 4 pairs of long marginal setae on the abdomen instead of only 2 pairs. The short dorsal and ventral setae are similar to those of *M. riouwensis* and *M. takahashii* in that the distance between the setal bases is greater than the length of a seta but it differs from *M. formicarii*, which has the distance between the setal bases shorter than the length of a seta.

Malaicoccus riouwensis Takahashi, 1950

Malaicoccus riouwensis Takahashi, 1950: 66. Holotype, ♀, INDONESIA: Riouw Is, Rempang, in association with ants of genus *Polyrhachis* sp. (probably lost).

Adult Female (Fig. 24)

External appearance described originally as 'Shining blackish brown, with no wax, in life, but dark reddish brown and a little shining when dry.'

Body of adult female pear-shaped with a constriction opposite first coxae. Anal lobes moderately developed. Anterior end of body with extensive sclerotization, which on the dorsal surface, extends around the antennal bases, then laterally and posteriorly around the first pair of ostioles. Ventrally the sclerotization extends over anterior end of head to just above clypeus. Circulus folded in available specimen but described by Takahashi as having deep constrictions at the sides and widest at anterior end. It is possible that Takahashi studied specimens that were distorted and that in reality the circulus is widest at posterior end. Labium 180 μ m long, with 21 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μ m long, 1 pair of lateral setae each 60 μ m long and 2 pairs of anterior setae, the longest 80 μ m long. Basal segment with 2 pairs short setae and 1 pair longer setae. Antennae 6-segmented, 2.33 mm long, thus longer than body; first segment 280 μ m long, the second 120 μ m, third 390 μ m, fourth 370 μ m, fifth 320 μ m and sixth 850 μ m and distinctly curved. Each segment densely covered with short setae ranging from 24 μ m long on the proximal segments to about 40 μ m towards terminal segment. Other slender setae 120 μ m long on second to sixth segments. Thick setae present on all segments, these about the length of the shortest slender setae but much fewer. Legs well developed, hind trochanter + femur 640 μ m long, hind tibia + tarsus 650 μ m long. Hind coxa with translucent pores on outer dorsal half. Short setae present on all leg segments, those on tibia numerous, about 28 μ m long, the distance between setal bases shorter than length of one seta. Claw 48 μ m long. Anal ring slender with 6 setae about 56 μ m long and a few minute pores. Ostioles well developed, of the type common to the genus, the anterior pair with setae on the lower lips, the posterior pair without setae. Long

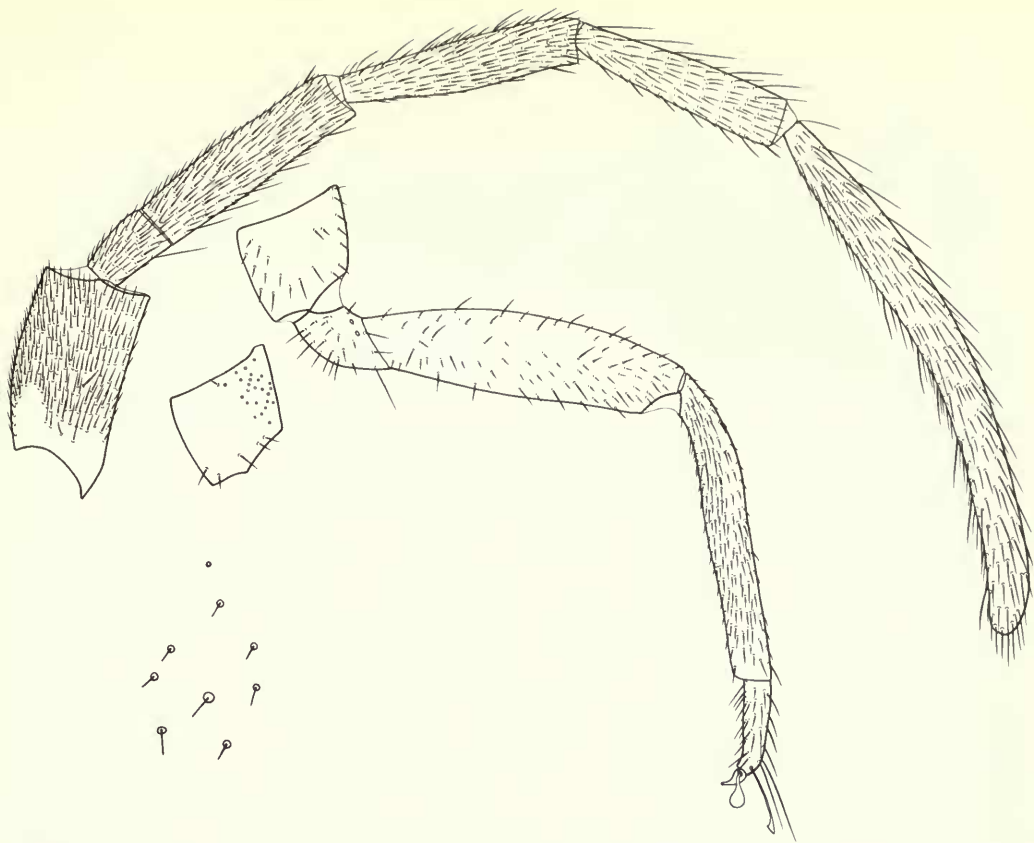


Fig. 24 *Malaicoccus riouwensis* Takahashi. Adult female. Specimen from Riouw Is, Rempang. Antenna, hind leg and dorsal setae.

marginal setae on anal lobes and eighth segment only, the two preceding segments with much shorter setae. Anal lobe setae comprising two long dorsal setae on an elongate area of sclerotization, the long setae about 0.9 mm long and the short setae about 350 μ m long. The long ventral setae on eighth segment 0.8 mm long and a short seta 130 μ m long on an elongate-oval sclerotized area. Seventh segment with one seta 220–250 μ m long and a shorter seta 72 μ m long on a round sclerotized area. Sixth segment with a seta 350–400 μ m long and a short seta 72 μ m long also on a round sclerotized area.

Body setae of various lengths. On the dorsal surface of head some of the stout setae are 30–44 μ m long with a few reaching 180 μ m. Others on posterior abdominal segments 44–100 μ m long, the longest on mid-line. Stout setae on venter 40–68 μ m long on all segments especially in median areas. Some setae on posterior abdominal segments 80 μ m long. Over the rest of the body there are abundant minute slender setae 5–20 μ m long, the larger proportion being the smallest. The setal bases are spaced apart about 1–2 times the length of a single seta. Ventral surface with a distinct tuft of short setae opposite first spiracles, the distance between these setal bases shorter than length of one seta. Trilocular pores present on both surfaces, sparse except for a few between the first spiracles. Minute simple pores few, each with a diameter smaller than a setal base. Tubular ducts represented by one or two on inner side of second and third coxae.

MATERIAL EXAMINED. INDONESIA: 1 ♀ (paratype), Riouw Is [Riau Is], Rempang, i.1946 (*R. Takahashi*) (USNM, Washington).

DISCUSSION. Mr Charles Chia-chu Tao has indicated that there is no type-material of this species in the Taiwan Agricultural Research Institute, Taipeh. Dr Sadao Takagi of the Entomological Institute, Hokkaido University, Sapporo, has informed the writer that there are no specimens in Takahashi's collection there and it must be assumed that the holotype is lost. Dr D. R. Miller of the United States Department of Agriculture, Beltsville, has kindly made available a single

paratype from the collections of the United States National Museum. This specimen is not in good condition and it has not been possible to illustrate it completely here.

The species is closely related to *M. takahashii* in having only 2 pairs of marginal setae nearly 1.0 mm long on abdomen on eighth segment and anal lobes. Anterior marginal setae to these are only 200–400 μm long. The most distinctive character separating this species from *M. takahashii* is the arrangement of the setae on the hind tibiae. These are short, about 28 μm long, and the distance between the setal bases on the disc of tibia is shorter than the length of one seta.

Malaicoccus takahashii sp. n.

Adult Female (Fig. 25)

An oval species, 1.7 mm long and 1.1 mm wide, with a deep constriction opposite first coxae. Anal lobes moderately developed. Anterior end of body heavily sclerotized; on the dorsum this sclerotization encircles antennal base and curves laterally and posteriorly to completely surround anterior ostioles. The sclerotization on ventral surface of head occupies the area immediately in front of clypeus to anterior margin but curves forward laterally before reaching ostiole. Antennae with the first segment 250 μm long, second 150 μm , third 360 μm , fourth 360 μm , fifth 350 μm and sixth 720 μm , the last segment curved. With a total length of 2.19 mm the antennae are longer than body. All antennal segments densely covered with short setae which range in length from 28 μm on the first segment to 48 μm on the last segment. Legs well developed, hind trochanter + femur 560 μm long, hind tibia + tarsus 550 μm long. All segments with quite stout setae in moderate numbers, the smallest on tarsus about 44 μm long with the space between setal bases usually same or greater than length of an average seta. Hind coxa with translucent pores on dorsal outer half. Claw 48 μm long. Circulus notched at either side, 188 μm wide. Labium 200 μm long and 130 μm wide with 20 pairs of setae, many of which are broken but their presence determined by setal bases. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae, 1 pair of lateral setae and 2 pairs of anterior setae. Medial segment with 7 pairs of setae and basal segment with 2 pairs of short setae and 1 pair of longer setae. Ostioles well developed, the anterior pair each with sclerotized posterior lip containing a few setae. Anal ring rather thin and easily distorted, with a few minute pores on periphery and 6 setae, each about 68 μm long. Long marginal setae each about 780 μm long on anal lobes and eighth segment only. Dorsal surface of anal lobes with an oval sclerotized area. Long marginal setae of eighth segment at apex of an elongate sclerotized area that also contains a seta about 80 μm long, each on a small sclerotized patch. Stout setae on dorsum confined to head, prothorax, eighth and posterior segments. On the head they are present mainly within the sclerotized areas but on the anal lobe segment they are present in two sclerotized crescentic areas anterior-lateral to anal ring. Although most of the stout setae are about 40 μm long some on eighth segment may reach 80 μm and others on head attain a length of 100 μm . Stout setae present on venter on all segments but on abdomen they are present in median areas only. These setae are about 40 μm long and on posterior segments of abdomen they are up to 90 μm long. Other body setae short, slender and numerous, evenly distributed over dorsal and ventral surfaces but absent on dorsal parts of head and thorax. A marginal tuft of short setae present opposite first spiracles, the distance between setal bases shorter than length of one seta. All the short setae range in length from 5 to 24 μm but the shorter setae are most numerous. Trilocular pores few but there is a noticeable concentration between the two first spiracles. Tubular ducts represented by one or two on inner side of second and third coxae. Simple circular pores minute, sparse.

Immature Instars

The three following instars are represented by poor distorted material and it has not been possible to illustrate them. Nevertheless, the long marginal setae are present only on the anal lobes as in the adult.

Third Instar Female

Body oval 1.25 mm long and 0.8 mm wide, constricted opposite first coxae. Head sclerotized around antennal bases, between clypeus and anterior head margin and around eyes on venter. Antennae 1.55 mm long, first segment 180 μm long, second segment 100 μm , third 250 μm , fourth 250 μm , fifth 200 μm and sixth 570 μm long; all segments with numerous slender setae. Legs with hind trochanter + femur 400 μm long, hind tibia + tarsus 410 μm long. Claw 40 μm long. Circulus 128 μm wide. Anal ring with a few

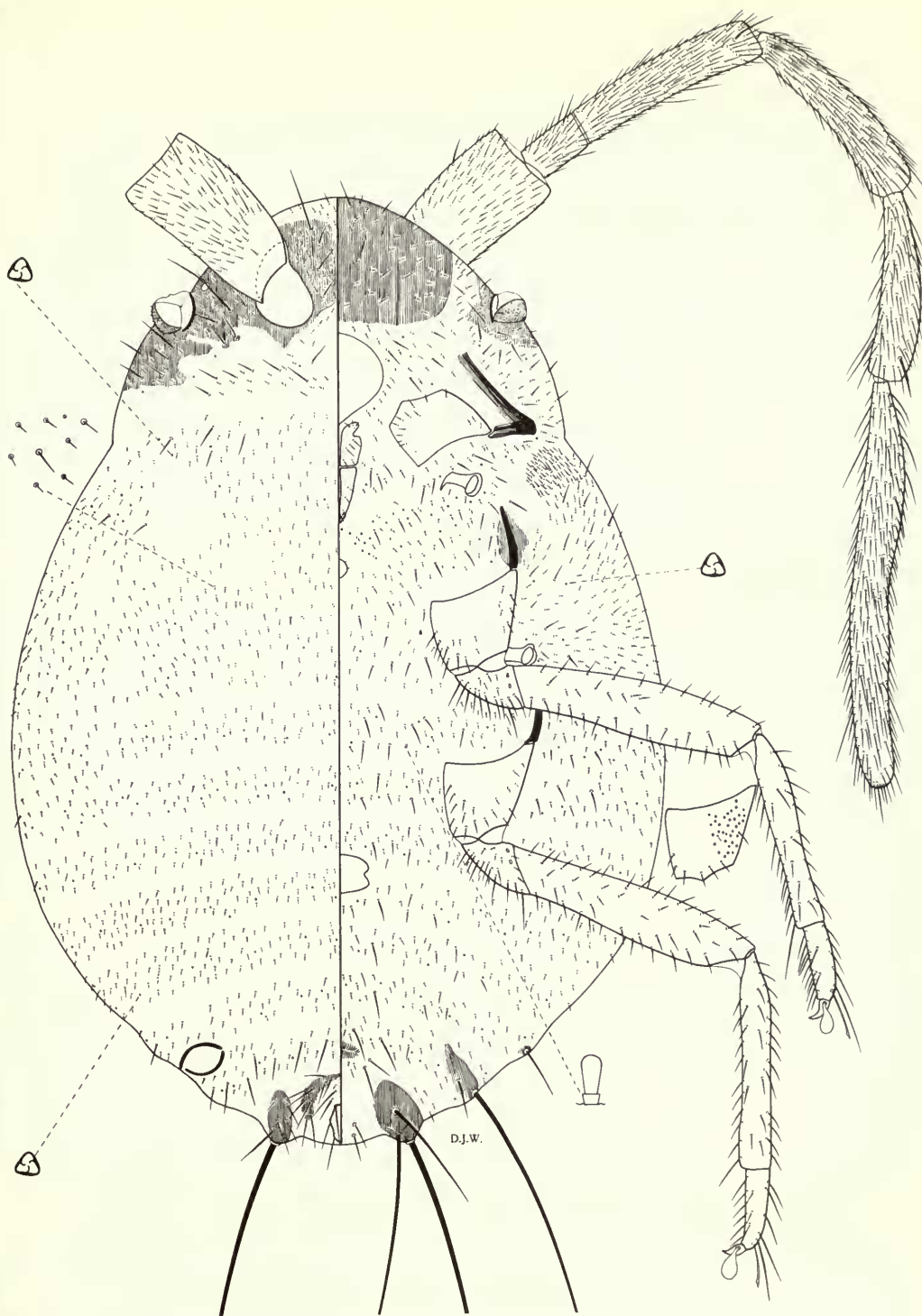


Fig. 25 *Malaicoccus takahashii* sp. n. Adult female. Specimen from Malaya, Kuala Lumpur.

minute pores and 6 setae each 60 μm long. Labium 160 μm long and 90 μm wide, with 16 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae each 56 μm long and 2 pairs of anterior setae, the longest 64 μm long. Medial segment with 3 pairs of setae, the longest 56 μm long. Each lobe of basal segment with a pair of short setae 20 μm long and one seta 44 μm long. Anal lobes sclerotized, each with one dorsal seta 0.8 mm long and a shorter seta 120 μm long, the ventral surface with one seta 0.8 mm long and another 280 μm long. Eighth segment with marginal setae 0.7 mm long and anterior marginal setae much shorter, each about 100 μm long, all on sclerotized areas. Dorsal and ventral setae numerous, of two types, a slender pointed type and a minute type with the seta much shorter than diameter of setal base.

Second Instar Female

Body 1.0 mm long and 0.55 mm wide, sclerotized on head between antennae on dorsum and around eyes on venter. Antennae 1.04 mm long, first segment 120 μm long, second 60 μm , third 170 μm , fourth and fifth each 160 μm and sixth 370 μm long. All segments with numerous slender setae. Hind trochanter + femur 290 μm long, hind tibia + tarsus 320 μm long. Claw 34 μm long. Circulus 80 μm wide. Anal ring slender with a few minute pores and each of the 6 setae 48 μm long. Labium 130 μm long and 70 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae 40 μm long and 2 pairs of anterior setae the longest 56 μm . Medial segment with a single pair of setae 44 μm long. Each lobe of basal segment with a pair of short setae 16 μm long and one seta 36 μm long. Anal lobes each with 4 setae, a dorsal and ventral 0.8 mm long, one dorsal 150 μm long and one ventral seta 270–320 μm long. Eighth segment with marginal setae 0.8 mm long. Anterior marginal setae 100 μm long on sclerotized areas. Trilocular pores, simple circular pores and minute setae very few.

First Instar

Body oval, 0.85 mm long and 0.45 mm wide. Antennae 680 μm long, the first segment 70 μm long, second 40 μm , third 100 μm , fourth 110 μm , fifth 100 μm and sixth 260 μm long. Hind trochanter + femur 220 μm long, hind tibia + tarsus 240 μm long. Claw 28 μm long. Anal ring setae 40 μm long. Anal lobes each with a dorsal and apical seta 0.85 mm long and a short dorsal and ventral seta 220 μm long. Eighth segment with marginal setae 0.85 mm long and anterior marginal setae 100–120 μm long, all on sclerotized areas. Labium 110 μm long and 60 μm wide with 14 pairs of setae. Apical segment with a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, a pair of lateral setae 32 μm long and 2 pairs of anterior setae, the longest 60 μm long. Medial segment with 1 pair of setae 52 μm long and each lobe of basal segment with a pair of short setae 16 μm long and 1 seta 40 μm long.

Holotype ♀, MALAYSIA: Malaya, Selangor, Kuala Lumpur, 11.viii.1943 (*R. Takahashi*) (BMNH, London).

Not included in type-series. MALAYSIA: 1 third instar ♀, 9 second instar ♀ and 2 first instars, same data as holotype (UM, Kuala Lumpur).

DISCUSSION. This is probably the undescribed species from Kuala Lumpur, on *Palaquium obovatum* (Sapotaceae), mentioned by Takahashi (1951) when discussing *M. formicarii*. Specimens were kindly made available by Dr Khoo Soo Ghee.

The most distinctive features of the adult female are the long pairs of setae present only on the anal lobes and eighth segment. These are about 780 μm long. The only other marginal setae, in addition to the normal body setae, are present on the seventh segment but these are only 80 μm long. A major character separating this species from *M. riouwensis* is the arrangement of the tibial setae, which although longer than those in *M. riouwensis*, are sparser, and on the tibial disc the distances between the setal bases are the same as or longer than the length of one seta.

PARAMYRMOCCUS Takahashi, 1941

Paramyrmococcus Takahashi, 1941 : 204. Type-species: *Paramyrmococcus chiengraiensis* Takahashi, by original designation and monotypy.

DESCRIPTION. Adult female with turbinate to oval body, tapering to a rounded posterior end, anal lobes obsolete. Antennae 6-segmented, about as long as body, first and second segments each with 1 or 2 stout setae, third to sixth segments densely covered with slender setae; second segment quite small, either shorter or just slightly longer than wide. Legs well developed, setae varying in size and number, claw

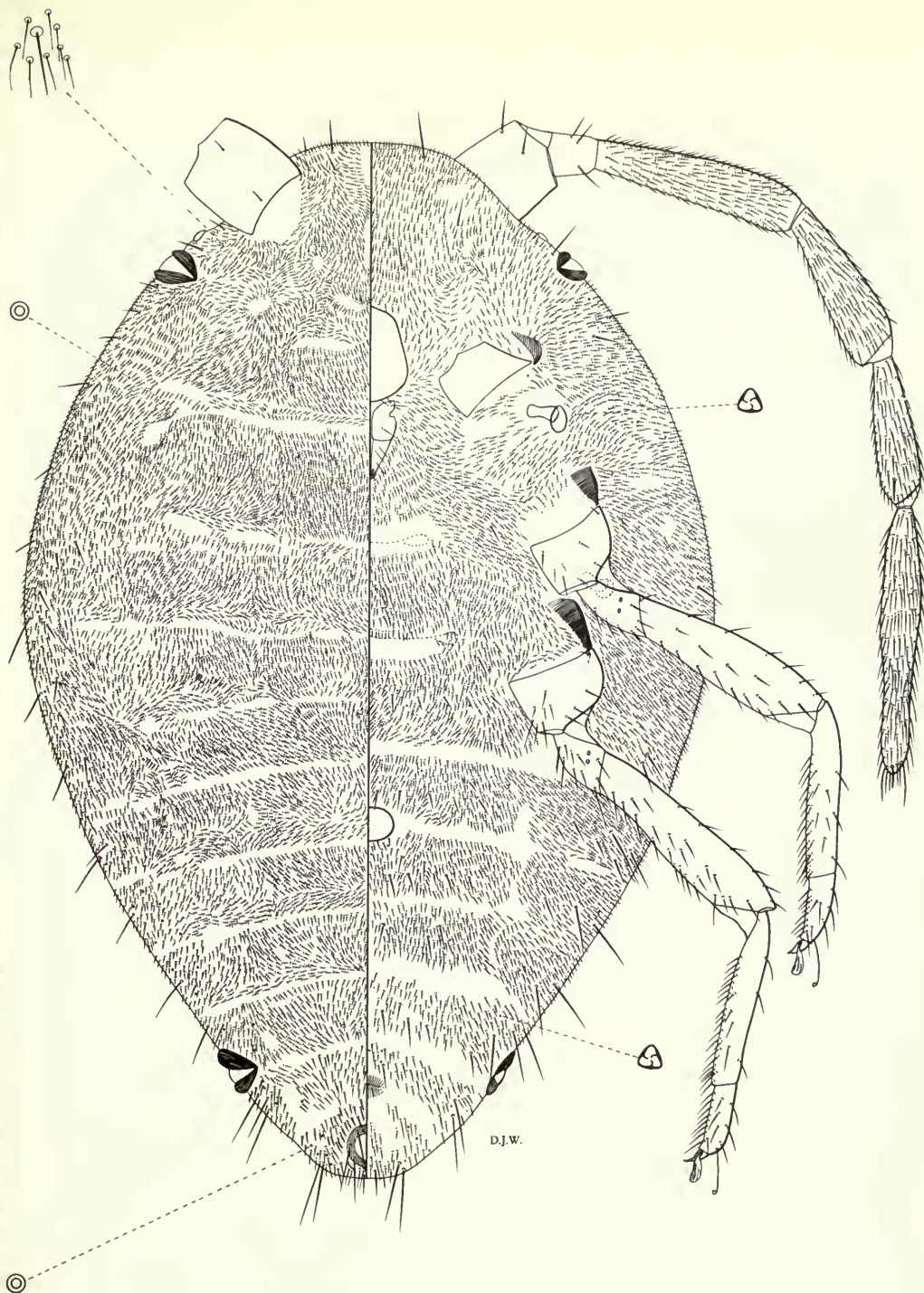


Fig. 26 *Paramyrmococcus chiengraiensis* Takahashi. Adult female. Specimen from Thailand, Chiengrai.

stout with a pair of wide flat digitules. Anal ring sclerotized with 6 setae but without pores. Ostioles situated on margins, of unusual development with large prominent lips that are heavily sclerotized but are devoid of setae. Circulus normal, usually oval. Body setae minute and slender, of unusual abundance, covering almost entire surface except for intersegmental areas, lying in definite directions giving the surface a wavy appearance. Other setae stout, situated mainly around margins; anal lobe setae not much more than twice diameter of anal ring in length. Trilocular pores few.

DISCUSSION. This genus is easily separated from the others in the *Allomyrmococcini* in being without recognizable anal lobes and in having short setae, only about twice diameter of anal ring in length, in normal positions of lobes. The immature instars are about the same shape as the adult but they tend to be more slender. Distinctive characters of the immature instars, based on *P. vietnamensis*, are short cylindrical and blunt setae on dorsum at least, which are replaced completely in the adult by short pointed setae.

DISTRIBUTION. The genus is known so far from Thailand and Vietnam.

Key to species of *Paramyrmococcus* (adult females)

Setae on hind tibial disc sparse, the distance between setal bases longer than length of a single seta.

Marginal stout setae on head and thorax attaining a length of 40 μm *chiengraiensis* Takahashi (p. 56)

Setae on hind tibial disc numerous, the distance between setal bases shorter than length of one seta.

Marginal stout setae on head and thorax attaining a length of 80 μm *vietnamensis* sp. n. (p. 61)

Paramyrmococcus chiengraiensis Takahashi, 1941

(Fig. 26)

Paramyrmococcus chiengraiensis Takahashi, 1941 : 204. Holotype ♀, THAILAND: Chiengrai, Lampang, on undetermined vine, attended by ant *Dolichoderus* sp. [= *Hypoclinea* sp.] (probably lost).

Paramyrmococcus chiengraiensis Takahashi; Takahashi, 1942 : 16.

Adult Female (Fig. 26)

External appearance in life not noted. On the slide, adult female turbinate or broadly oval, widest at mesothorax, posterior end of body tapering, rounded, about 2.0 mm long and 1.25 mm wide. Antennae about 1.78 mm long, first segment 170 μm , second 90 μm , third 430 μm , fourth 320 μm , fifth 270 μm and sixth 500 μm long. Second segment about 80 μm wide and thus slightly longer than wide. Sixth segment widest at proximal half, which then narrows before becoming slightly swollen. The first two segments with 1 or 2 stout setae only, the remaining segments densely covered with slender setae about 32 μm long on third segment and as long as 44 μm on sixth segment. Legs well developed, hind trochanter + femur 520 μm long, femur at its widest about 150 μm ; hind tibia + tarsus 450–460 μm long, the tarsus 80 μm at its widest and distinctly shorter than trochanter + femur. Slender setae on dorsal and ventral surfaces of tibia quite sparse, about 40 μm long, the spaces between setal bases much greater than length of one seta. Claw 40 μm long. Labium 160 μm long and 140 μm wide, with 14 pairs of setae. Apical segment with two pairs of posterior setae, a pair of minute apical setae and four pairs of subapical setae each 28 μm long except the second pair, which are more slender and shorter, 20 μm long. Lateral setae and 2 pairs of anterior setae present, each 40 μm long. Medial segment with 1 pair of setae each 40 μm long and each lobe of basal segment with 2 pairs of setae 20 μm long and 1 pair 40 μm long. Circulus oval to subrectangular, 60–104 μm wide. Ostioles well developed, on the margins, with protruding sclerotized lips, without setae. Anal ring 72–80 μm wide with 6 setae 70–80 μm long.

Body setae mainly slender, about 16 μm long but with a smaller proportion of longer setae about 20 μm long evenly distributed among the smaller, covering almost entire surface except for intersegmental areas; the distance between the setal bases much shorter than the length of one seta. On the dorsum the setae are even closer together than on venter. Other setae present are stout, those on margins of head and thorax on both surfaces 40–50 μm long, on margins of abdomen 60–80 μm long except on eighth segment where they are 112 μm long and the two ventral anal lobe setae about 120 μm long. Mid-ventral setae about 40 μm long. Trilocular pores sparse, apparently on venter only. Round pores on dorsal margins few, each slightly smaller than a trilocular pore and with obscure structure.

MATERIAL EXAMINED. THAILAND: 2 ♀, 'Siam', Chiengrai, 16.iv.1940 (*R. Takahashi*) (TARI, Taipheh).

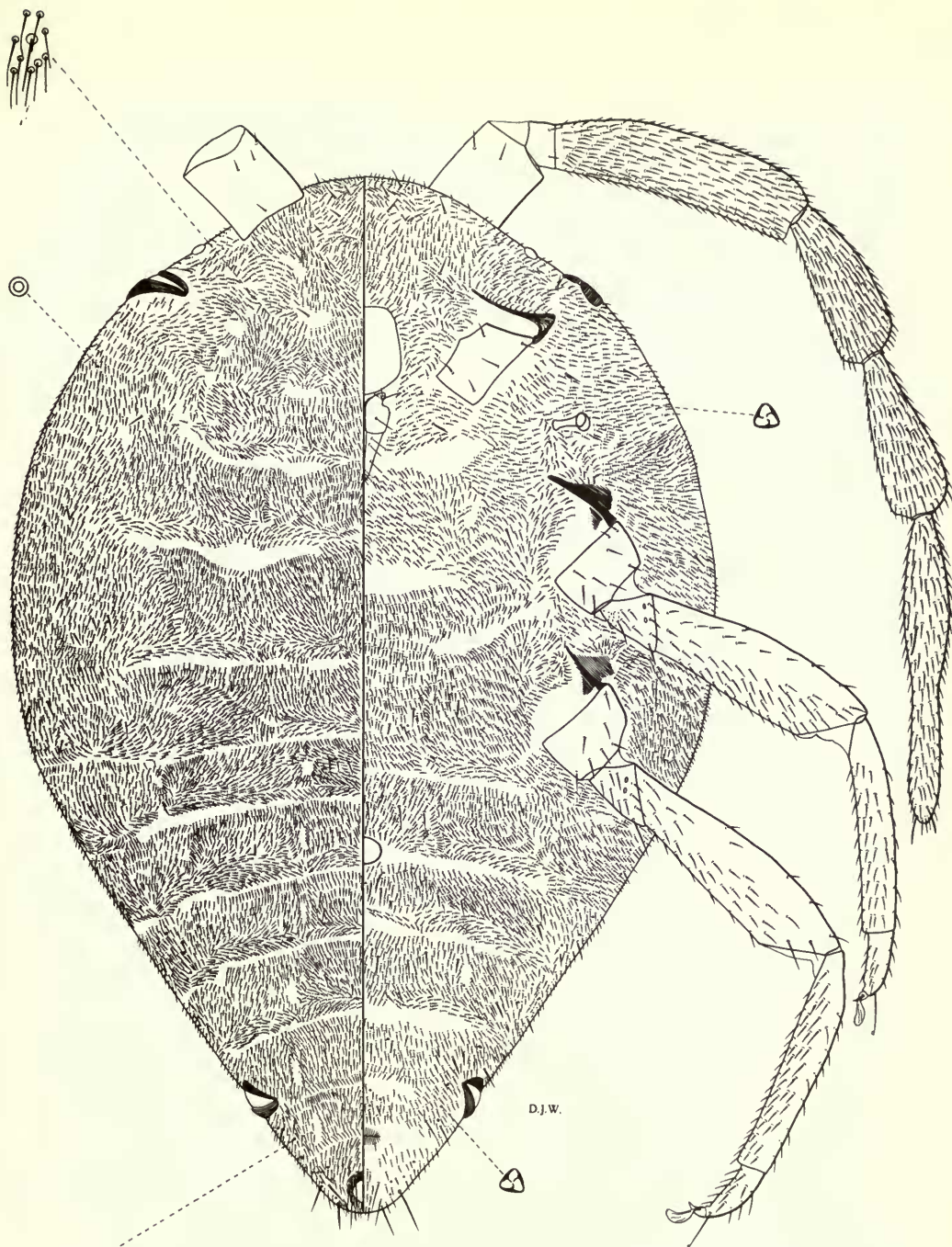


Fig. 27 *Paramyrmococcus vietnamensis* sp. n. Adult female. Specimen from Vietnam, Da Lat.

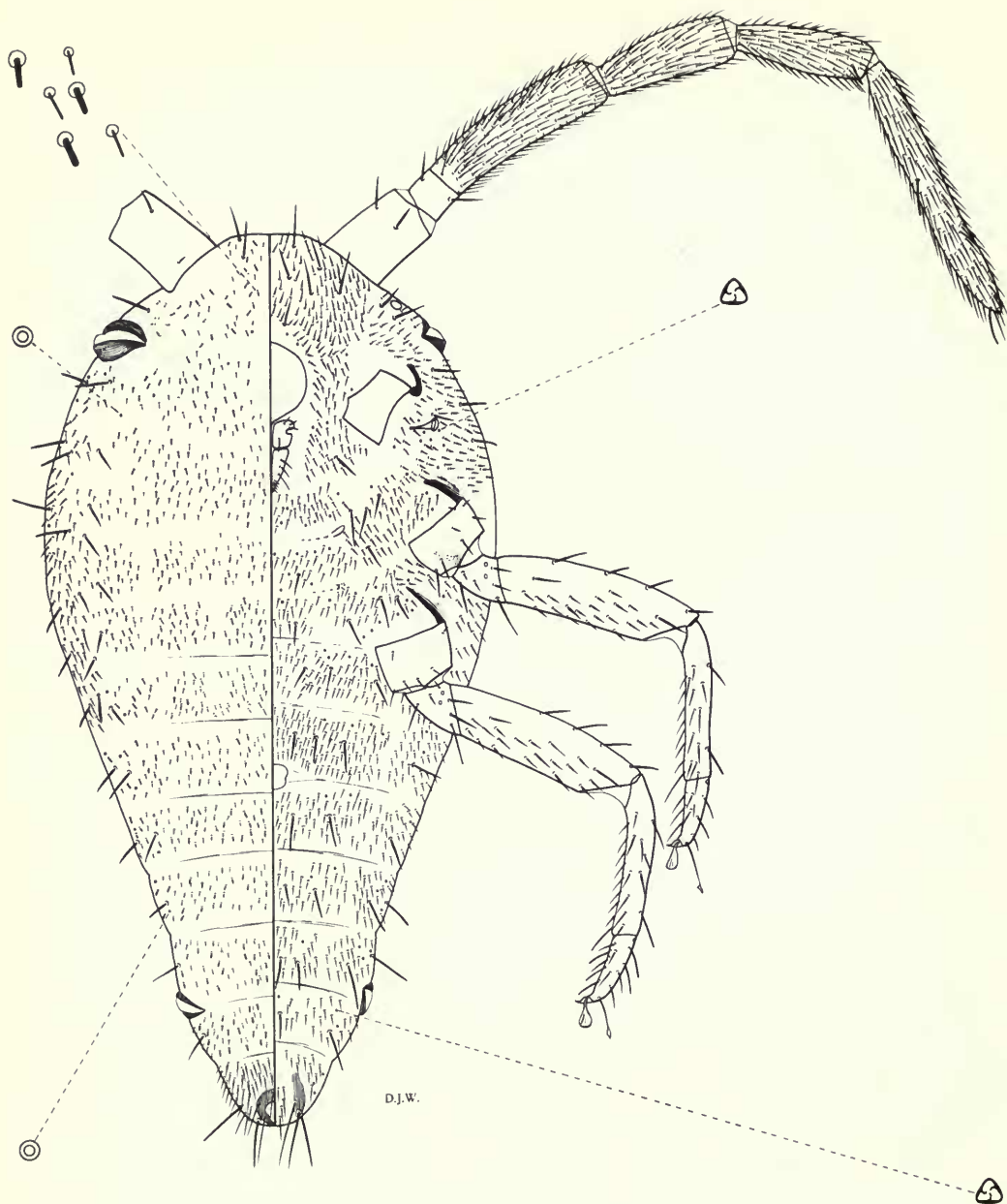


Fig. 28 *Paramyrmococcus vietnamensis* sp. n. Third instar female.

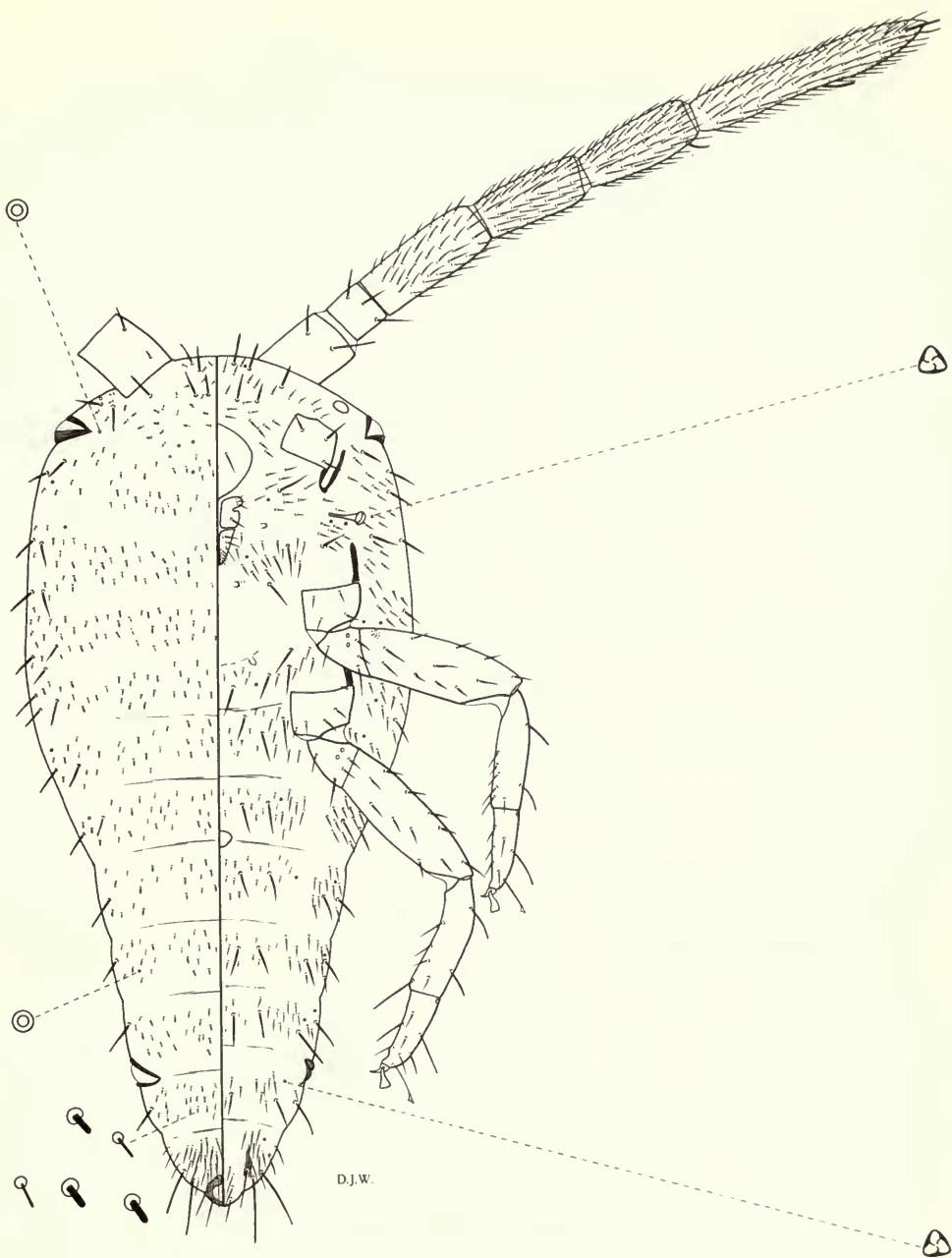


Fig. 29 *Paramyrmococcus vietnamensis* sp. n. Second instar female.

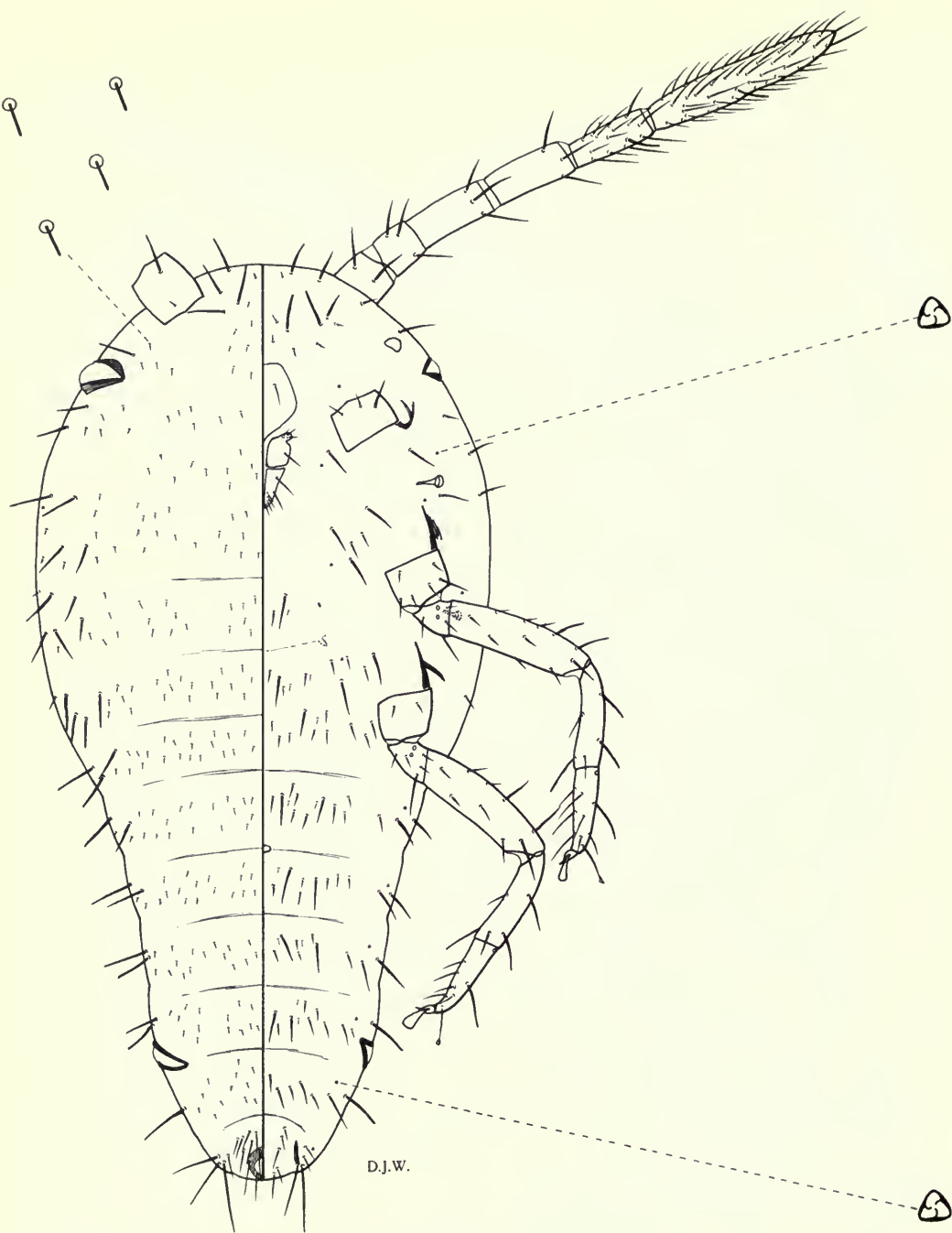


Fig. 30 *Paramyrmococcus vietnamensis* sp. n. First instar.

DISCUSSION. The two specimens examined seem to belong to Takahashi's original type-series. They were kindly made available by Mr Charles Chia-chu Tao of the Taiwan Agricultural Research Institute, Taipeh.

Paramyrmococcus vietnamensis sp. n.

Adult Female (Fig. 27)

External appearance not known. When mounted on the slide, body turbinate, widest at mesothorax, posterior end narrow and rounded, length 2.1 mm, width 1.3 mm. Antennae 1.9–2.0 mm long and thus about as long as body. On an antenna measuring 1.9 mm long the segment lengths are: first 200 μ m, second 60 μ m, third 470 μ m, fourth 290 μ m, fifth 290 μ m and sixth 590 μ m. The second segment 80 μ m wide and, therefore, wider than long; sixth segment with a constriction at about middle but basal part wider than terminal part. First and second segments each with one or two stout setae only, remaining segments densely covered with slender setae ranging from about 40 μ m long on third segment to 60 μ m long on sixth segment. Legs well developed, hind trochanter + femur 560–570 μ m long, the widest part of femur about 150 μ m at distal end; hind tibia + tarsus 560–590 μ m long, thus same length as trochanter + femur or longer, widest part of tarsus 80 μ m. Legs with 1 or 2 stout blunt setae and covered with slender setae about 40 μ m long, which on the disc of hind tibia are set close together on dorsal and ventral surfaces so that spaces between are shorter than length of one seta. Claw 40 μ m long. Ostioles well developed, situated on margins, each with prominent heavily sclerotized lips without setae. Circulus oval, 56–60 μ m wide but sometimes with slight constrictions on either side, situated between fourth and fifth segments. Labium 172 μ m long and 144 μ m wide with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μ m long, 1 pair of lateral setae 40 μ m long and 2 pairs of anterior setae, the longest 60 μ m. Medial segment with 1 pair of setae each 44 μ m long and basal segment with 2 pairs of setae 24 μ m long and 1 pair 40 μ m long. Anal ring 68–72 μ m wide, with 6 setae about 80 μ m long. Body setae abundant and covering almost entire surface except for inter-segmental spaces. For the most part the setae are slender, about 16 μ m long on dorsum and 16–20 μ m long on venter, the spaces between the setal bases much shorter than length of one seta but even so these spaces are shorter on dorsum than on venter. Some of the slender setae are a little longer and are easily discernible by the larger setal bases. The directions of the slender setae form definite patterns giving the surface a wavy appearance. Stout setae, easily recognized by the large setal bases, present in small numbers around margins of both surfaces and across ventral abdominal segments, about 25–40 μ m long but on the normal positions of the lobes there are usually 2 dorsal and 2 ventral setae about 120 μ m long and on margins of eighth segment there are 1 or 2 setae about 100 μ m long. Trilocular pores apparently confined to venter where they are sparse. Dorsal marginal and submarginal areas with a few round pores slightly smaller in diameter than a trilocular pore but with an obscure structure.

Third Instar Female (Fig. 28)

Body pyriform, 1.7 mm long and 0.7 mm wide. Antennae 1.57 mm long, the sixth segment with a constriction in the middle. First and second segments with a few stout setae only, third to sixth segments with numerous slender pointed setae but not so numerous as in adult. Labium 160 μ m long and 120 μ m wide with same number of setae as in adult. Apical segment with 4 pairs of subapical setae each 24 μ m long, 1 pair of lateral setae each 32 μ m long and 2 pairs of anterior setae 40 μ m long. Medial setae 40 μ m long and basal setae 20 μ m and 36 μ m long. Legs with hind trochanter + femur 450 μ m long, hind tibia + tarsus 460 μ m long. Apart from stout setae 40–55 μ m long there are also numerous slender pointed setae 28–32 μ m long. Claw 36 μ m long. Ostioles prominent with wide sclerotized lips. Circulus about 60 μ m wide with a distinct notch at either side. Anal ring 64 μ m wide with the 6 setae about 72 μ m long.

Dorsal surface with numerous setae of different sizes. Long stout marginal setae present about 60 μ m long, each usually with a blunt or irregular apex and often showing a discharge. Shorter pointed setae on margins of head and thorax and on last segment. Evenly distributed over dorsum are two types of minute setae, blunt with parallel sides. One type is extremely thin and about 6 μ m long, the other type about twice as thick, about 5 μ m long and interspersed with the thin type, both types being present in about equal numbers. Ventral setae only occasionally represented by the minute blunt type, replaced by numerous pointed setae 16–20 μ m long, these also accompanied with long thick blunt setae. Trilocular pores few, on ventral surface only but they are more numerous in median areas of thorax. Simple circular pores, sparse, around dorsal margins.

Second Instar Female (Fig. 29)

Similar to third instar but with the following major differences. Body 1.4 mm long and 0.67–0.77 mm wide. Antennae 1.05–1.10 mm long, with long stout setae on first two segments and much more slender setae on third to sixth segments, these quite abundant and ranging in length from 35 to 50 μ m. Legs well developed with hind trochanter + femur 320–350 μ m long, tibia + tarsus 320–350 μ m long. Claw 30–36 μ m long. Labium 128 μ m long and 88 μ m wide, with setae similar to those of third stage but longest basal setae only 32 μ m long. Circulus with a small notch on either side, about 36 μ m wide. Anal ring 52 μ m wide, the anal ring setae about 60 μ m long. Body setae less numerous than in previous stage but with the same two types of minute setae on dorsum. The same two types are present also on venter but they are interspersed with long blunt setae and normal pointed setae. Trilocular pores sparse, confined to venter. Simple circular pores present in small numbers around dorsal margins and on prothorax at a point opposite clypeus.

First Instar (Fig. 30)

Body elongate-pyriform, about 1.2 mm long and 0.57 mm wide at thorax, posterior end of body rounded, anal lobes barely perceptible. Antennae 720 μ m long, the first four segments each with a few stout setae about 50 μ m long, the tips often damaged and each seta having a fleshy appearance. The two terminal segments with much more numerous slender pointed setae, these also 50 μ m long; sixth segment with a slight constriction near middle. Legs well developed, hind trochanter + femur 250 μ m long, hind tibia + tarsus 260 μ m long. Claw 30 μ m long. Circulus situated between fourth and fifth segments, small and oval, about 28 μ m wide. Anal ring 40 μ m wide, without pores but with 6 setae each about 45 μ m long. Labium 108 μ m long and 80 μ m wide, differing from previous stage in that some setae are shorter, the anterior setae 36 μ m long, medial setae 36 μ m long and basal segment with 2 pairs of setae each 12 μ m long and 1 pair 32 μ m long. Ostioles on margins with heavily sclerotized lips, without setae.

Body setae of various sizes. Anal lobe setae comprising 3 dorsal and 2 ventral, each about 110 μ m long, the bases of the ventral setae at the end of an elongate bar-like area of sclerotization. Margins of dorsum with thick setae usually about 40 μ m long, each of which is irregularly blunt at apex and showing what appears to be a discharge. Dorsum with thin type of minute setae only, about 6 μ m long. Anal lobe segment without these setae but with pointed setae about 35 μ m long. Ventral surface with long setae around margins, some of which attain a length of 50 μ m. Other long setae present in median areas of segments, these interspersed with minute setae similar to those on dorsum accompanied with short pointed setae 12–24 μ m long. Trilocular pores quite sparse, there being a few around the ventral margins and on thorax.

Holotype ♀, VIETNAM: South, Da Lat (37 km SE.), Chute de Gauhgah, 25.iv.1960 (R. E. Leech).

Paratypes and many immatures, VIETNAM: South, Da Lat, same data as holotype (16 ♀, BMNH, London; 2 ♀, USNM, Washington; 2 ♀, TARI, Taipei; 2 ♀, IEAUN, Portici; 2 ♀, RNH, Leiden).

DISCUSSION. This species is close to *P. chiengraiensis* but differs mainly in the characters given already in the key to species.

RHIZOECINAE

The genera *Eumyrmococcus* and *Xenococcus* are aberrant and are assigned to this subfamily mainly on the bases of the width-length ratio of the labium and the long slender claws with short setose digitules, characters which have been discussed in the section on classification.

Both genera and the South American genus *Chavesia* differ from others in the Rhizoecinae in possessing minute setae densely covering the dorsum. *Chavesia* and *Eumyrmococcus* have the cephalothorax strongly dilated and all three genera have the abdomen tapering or abruptly narrowed. The three genera may be separated by the following key.

Key to adult females of the anomalous ant-attended genera of Rhizoecinae

- 1 Antennae 2-segmented, not more than 180 μ m long. Circulus absent **EUMYRMOCOCCUS** (p. 63)
- Antennae 4- or 5-segmented, at least 280 μ m long. One or two circuli present 2
- 2 Antennae well developed, as long as body. Anal ring terminal. Two circuli present **XENOCOCCUS** (p. 63)
- Antennae shorter than width of body. Anal ring situated some distance from apex of abdomen, near base of well-developed anal lobes. One circulus present **CHAVESIA**

EUMYRMOCOCCUS Silvestri, 1926

Eumyrmococcus Silvestri, 1926 : 271. Type-species: *Eumyrmococcus smithii* Silvestri, by original designation and monotypy.

Eumyrmococcus Silvestri; Williams, 1969 : 336.

Eumyrmococcus Silvestri; Williams, 1970 : 138.

The description of this genus is virtually the same as the type-species given already by Williams (1970). The genus was placed in the tribe Rhizoecini by Williams (1969) and this assignment has been confirmed here by a further study of the labium which has a width-length ratio of about 1 : 2.

Eumyrmococcus smithii Silvestri, 1926

(Fig. 31)

Eumyrmococcus smithii Silvestri, 1926 : 273. LECTOTYPE ♀, CHINA: Macao [on roots of plants, attended by ant *Acropyga* (*Rhizomyrma*) *sauteri* Forel] (IEAUN, Portici), here designated [examined].

Eumyrmococcus smithii Silvestri; Silvestri, 1927 : 254.

Eumyrmococcus smithii Silvestri; Takahashi, 1934 : 2.

Eumyrmococcus smithii Silvestri; Williams, 1970 : 138.

Williams (1970) has described and illustrated this species recently and the illustration from the *Bulletin of Entomological Research* is reproduced with permission but with slight modifications. The labium was too distorted in the material studied at the time but further specimens of the type-series have become available through the kindness of Dr A. Tranfaglia and it is now possible to modify the description of the labium. There is no specimen with a perfect labium and the following description of this structure remains tentative.

Length 156–160 µm and 80 µm wide, apical segment with 2 pairs of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae. One pair of lateral setae and 2 pairs of anterior setae. The subapical setae become longer and stouter towards the base. Medial segment with 1 pair of medial setae and basal segment with 2 pairs of short setae and 1 longer pair. Almost all the setae are curled in the specimens examined and the lengths are difficult to determine.

MATERIAL EXAMINED. *Eumyrmococcus smithii* Silvestri, lectotype ♀, CHINA: Macao (IEAUN, Portici).

CHINA: 4 ♀, same data as lectotype (IEAUN, Portici) (1 ♀, BMNH, London); 1 ♀, Shanghai (IEAUN, Portici); 4 ♀, Taipo Market, 26.xii.1924 (*F. Silvestri*) (2 ♀, BMNH, London; 2 ♀, IEAUN, Portici) (mounted from Silvestri's alcohol material). TAIWAN: 4 ♀, Taichu, on sugarcane, 24.ii.1933 (*M. Yangihara*) (TARI, Taipch).

DISCUSSION. The width-length ratio of 1 : 2 of the labium confirms the assignment of the genus to the Rhizoecinae agreeing also to the definition of the subfamily by Koteja (1974a).

XENOCOCCUS Silvestri, 1924

Xenococcus Silvestri, 1924 : 312. Type-species: *Xenococcus annandalei* Silvestri, by original designation and monotypy.

Xenococcus Silvestri; Silvestri, 1926 : 275.

Xenococcus Silvestri; Silvestri, 1927 : 253.

DESCRIPTION. Mealybugs with broadly-oval body, abdomen tapering to narrow sclerotized terminal segment. Apex with dorsal anal ring projecting beyond ventral lobes. Anal ring with 8 setae, the anterior 2 pairs slender and the posterior pair thick and long, the posteriormost often on ventral surface. Anal lobes with numerous long stout setae. Antennae 4-segmented, nearly as long as body, the first segment long and wide, articulating with much narrower second segment containing small teeth at proximal end fitting into grooves at distal end of first segment. All segments with long pointed setae. Legs long and well developed with long slender claw, at base of which are 2 short setose digitules. Labium long and slender with a width-length ratio in excess of 1 : 2. Subapical setae reaching more than half distance to base of apical segment. Two circuli present in adult, circular and slightly conical. Body setae densely covering dorsum. Ventral setae longer and not so numerous. Pores and ducts absent.

Immature instars similar in shape to adult but with fewer setae and with only a single circulus.

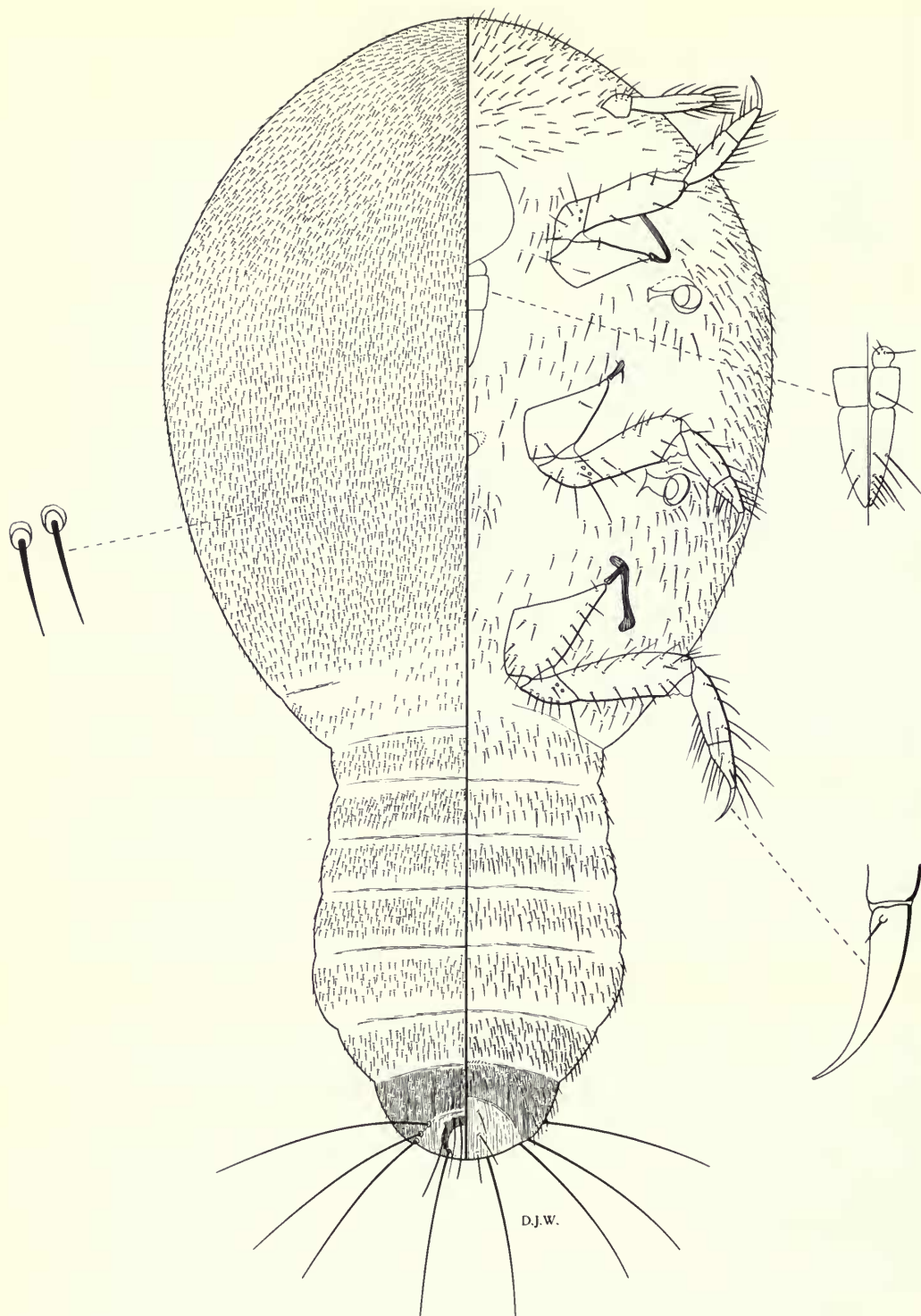


Fig. 31 *Eumyrmococcus smithii* Silvestri. Adult female. Specimen from Japan.

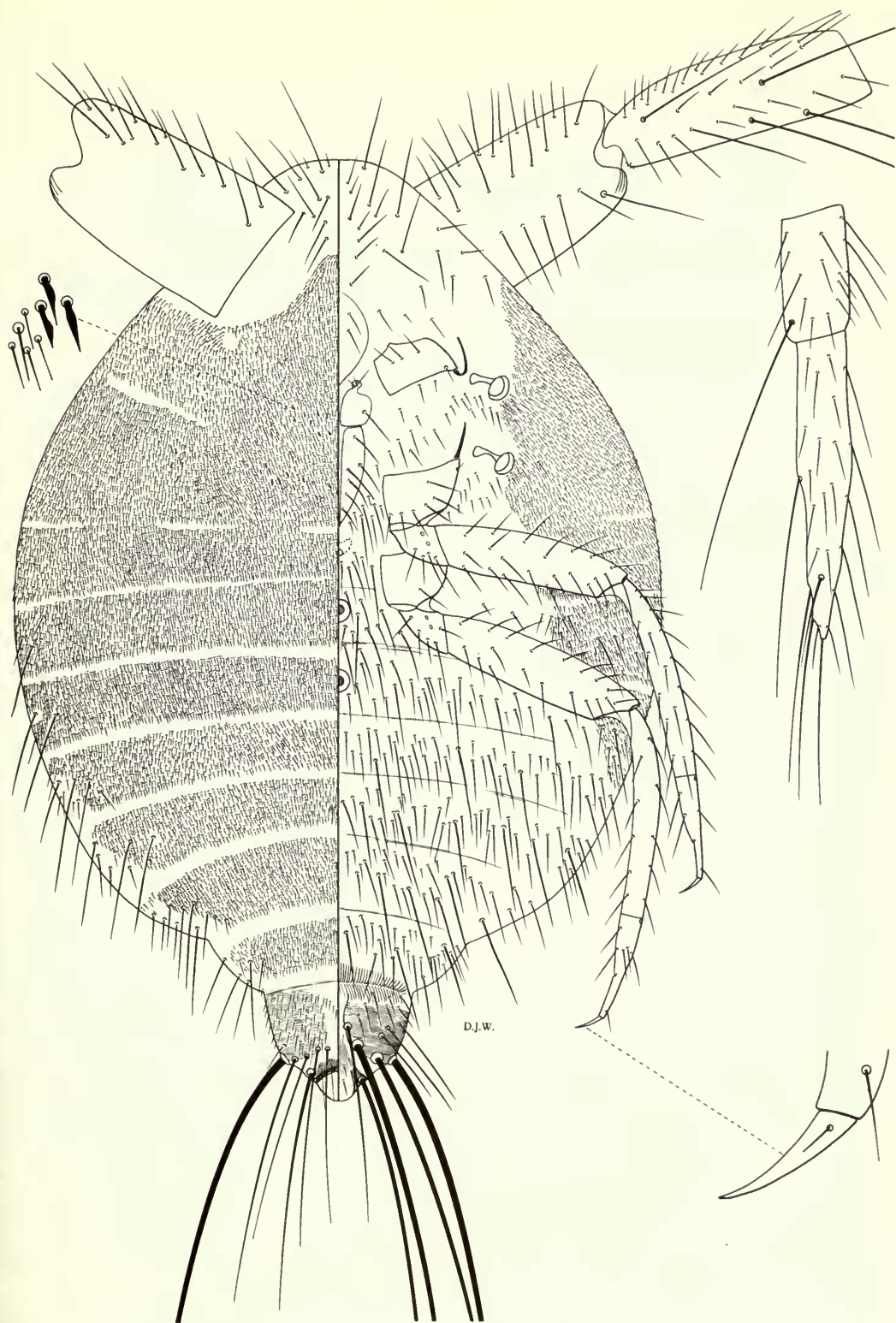


Fig. 32 *Xenococcus annandalei* Silvestri. Adult female. Specimen from India, Barkuda I.

DISCUSSION. The most distinctive character of this genus is the peculiar pair of antennae which are unlike any known in the Pseudococcidae. An anal ring projecting beyond ventral anal lobes, the long stout anal lobe setae and the dense covering of dorsal pointed setae, are characters shared with some of the Allomyrmococcini but the long slender claw with short setose digitules, the round sclerotized circuli and the 4-segmented antennae are characters which seem to belong to the Rhizocini of the subfamily Rhizocinae.

De Lotto (1977) has recently described *Xenococcus scorpoides*, an interesting species from South Africa, from the nests of *Acropyga* sp. and the first anomalous species from the African continent. In possessing short 4-segmented antennae, shorter legs with thick claws, it does not seem to be congeneric with *X. annandalei* but probably lies somewhere between *Chavesia* and *Xenococcus*.

DISTRIBUTION. At present the genus is known from India, Malaya, Vietnam and Hong Kong.

Xenococcus annandalei Silvestri, 1924

Xenococcus annandalei Silvestri, 1924: 312. LECTOTYPE ♀, INDIA: Barkuda I. [Chilka Lake, Madras District (now Orissa Province), on roots of *Ficus obtusa*, with ants *Acropyga acutiventris* Roger] (IEAUN, Portici), here designated [examined].

Xenococcus annandalei Silvestri; Silvestri, 1926: 275.

Xenococcus annandalei Silvestri; Silvestri, 1927: 253.

Adult Female (Fig. 32)

Adult female in alcohol ovoid, abdomen tapering, posterior end curved slightly upwards, antennae strongly geniculate, lying in a posterior direction almost parallel to body margins.

On the slide, when flattened, broadly oval, 1.6–1.7 mm long and 1.1–1.4 mm wide, abdomen tapering to a narrow sclerotized last segment almost as long as broad with the anal ring at apex of dorsum projecting beyond a pair of ventral lobes that curve inwards almost to mid-line. Antennae with 4 segments, of a distinctive shape and structure, 1.35–1.54 mm long, attached to dorsal surface of head. One of longest antennae with first segment 380 µm long and 230 µm at widest. Remainder of antenna much narrower, the second segment 440 µm long, the third 200 µm long, and last segment tapering, 520 µm long. All segments with numerous long slender setae of different sizes, the longest on third and fourth segments. Length of longest seta, on third segment 500 µm. Joint between first and second segments distinctive, there being small tooth-like projections on proximal lower corner of second segment which fit into small grooves on posterior distal edge of first segment. Legs well developed, hind trochanter + femur 410–470 µm long, hind tibia + tarsus 470–550 µm long. Tarsus tapering to a distance of about half its length which then becomes narrow and subparallel towards distal end, a small notch also present on inner margin at point between tapering part and narrow extremity. Each leg segment with setae of various lengths but mostly long and slender, the longest on femur about 180 µm long. Claw unusually long and narrow with a length of 40–44 µm and with a pair of setose digitules, each 16 µm long. Two circuli present situated in middle of third and fourth segments. Each circulus round, 40 µm in diameter, with a sclerotized outer rim and with the inner surface forming a cup. Labium unusually elongate; in alcohol specimens 250 µm long and 110 µm wide but, when flattened on slide, about 128 µm wide with 12 or 13 pairs of setae. Apical segment tending to be lanceolate instead of the usual conical shape, with 2 pairs of posterior setae, a pair of apical setae 20 µm long, 4 pairs of subapical setae extending towards base of segment, the distal setae about 20 µm long and the others becoming longer towards the base. Anterior setae represented by a single pair each 100 µm long but a single lateral pair each 80 µm long may be present or absent. Medial segment with a single pair of medial setae each about 75 µm long. Basal segment with a pair of setae each 10 µm long and a single setae 64 µm long on each lobe. Anal ring situated mainly on dorsal surface but often curving to ventral surface, sclerotized, about 120 µm wide at widest point, without pores but apparently with 4 pairs of setae around perimeter, there being 2 pairs of slender anterior setae each about 110 µm long and an outer pair of stouter setae each 400 µm long. A pair of stout setae about 0.8 mm long usually on ventral surface seem to belong to ring. Vulva occupying almost total width of its segment. Posterior setae stout, each about 1.0 mm long, there being 4 such pairs, 1 pair on lateral edges of dorsum anterior to anal ring and 3 pairs on posterior edge of ventral lobes. An anterior pair of setae on inner edges of these lobes much shorter and more slender.

Dorsal setae abundant, covering almost entire surface except for head and intersegmental areas, the spaces between setal bases much shorter than length of one seta. The most abundant are slender, 20–28 µm long but there are some, interspersed with these, about 40 µm long and which may be detected by the

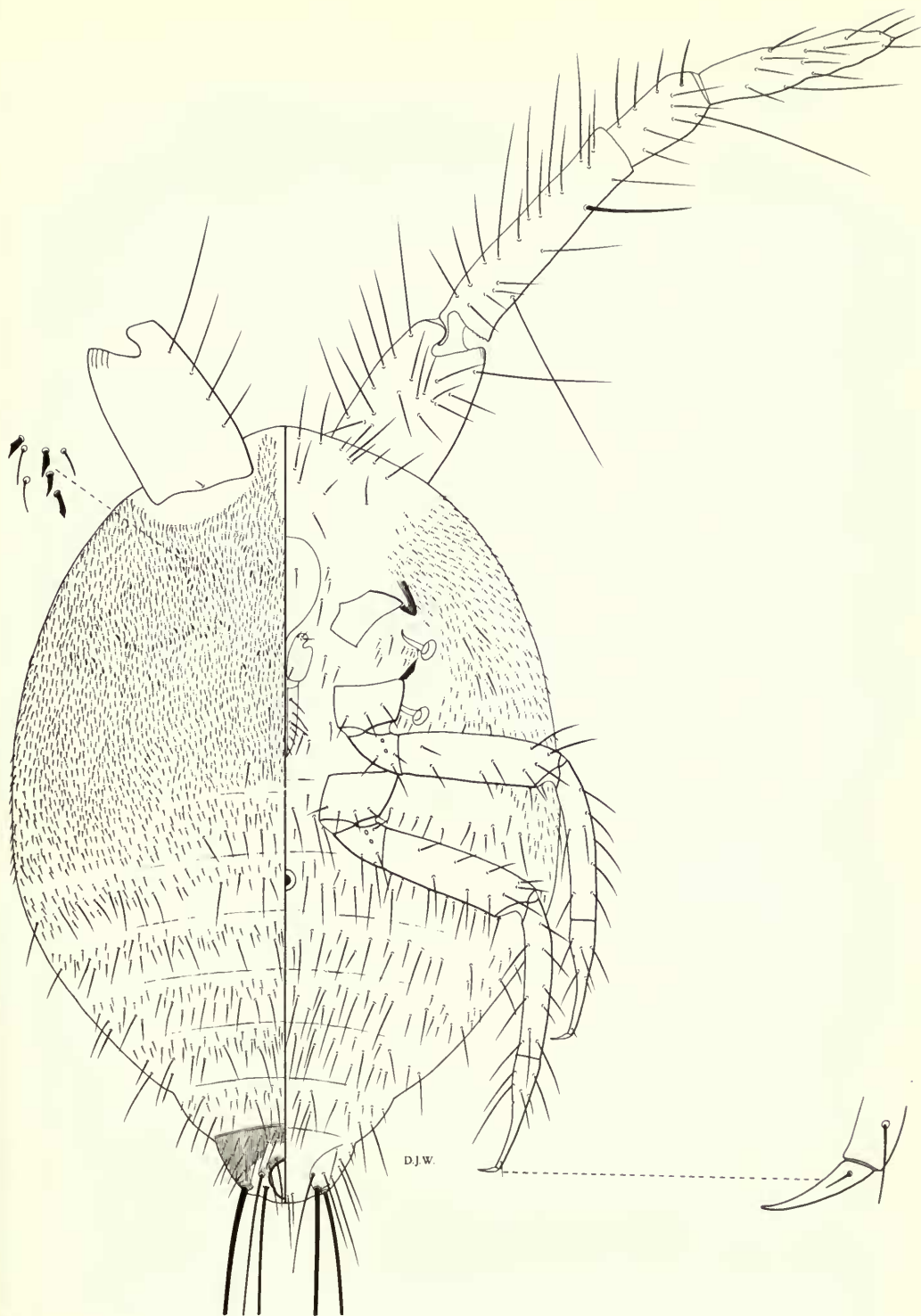


Fig. 33 *Xenococcus annandalei* Silvestri. Third instar female.

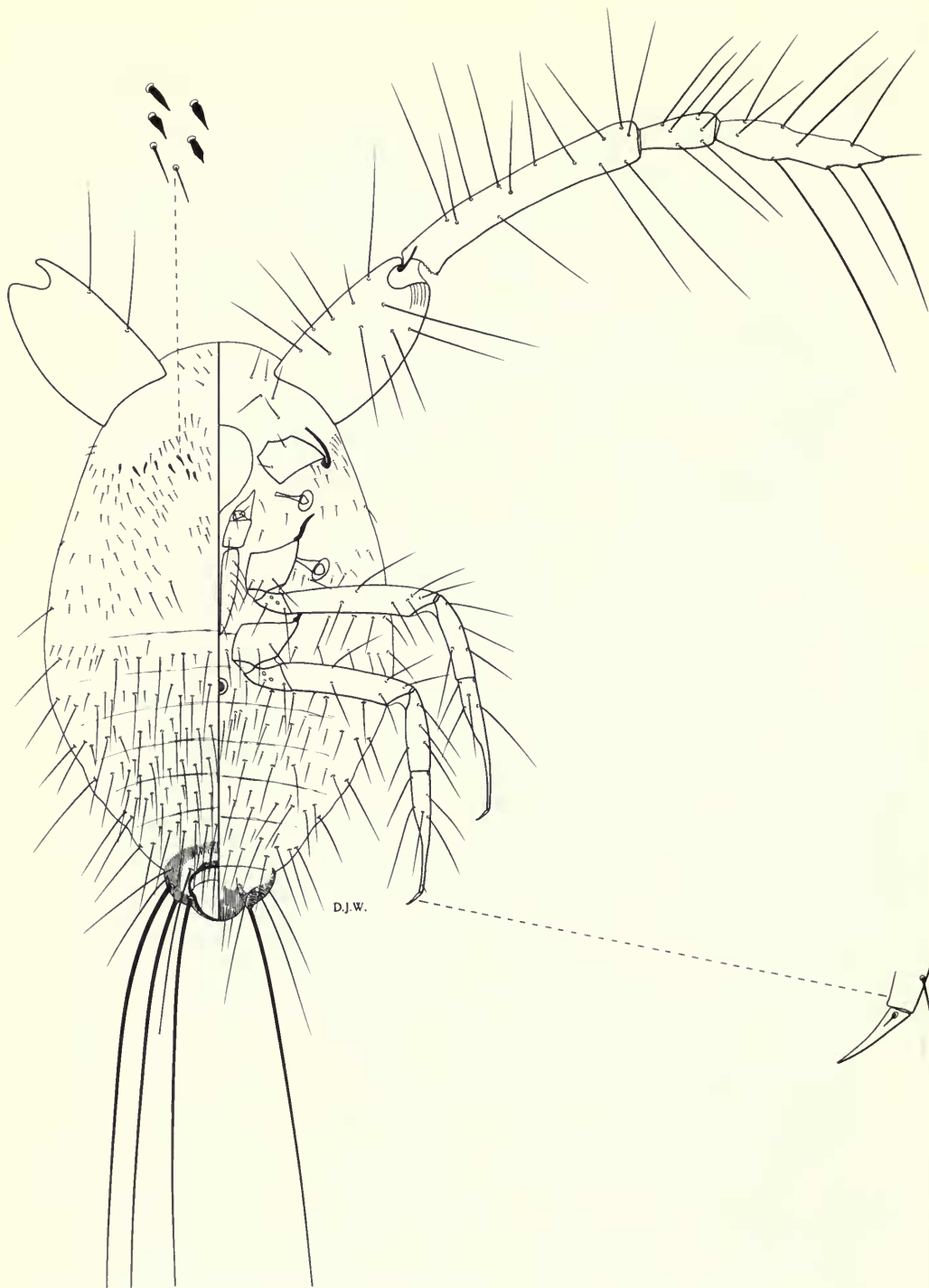


Fig. 34 *Xenococcus annandalei* Silvestri. First instar. Specimen from India, Mysore, on coconut roots.

slightly larger setal bases. On prothorax and mesothorax there are short flat setae in varying numbers but usually few. Each is variously shaped and often peculiarly angled. Setae on last segment longer than usual body setae and just anterior to anal ring a fringe of long setae present comprising 2–3 median pairs each about 480 μm long and a lateral pair usually stouter about 560 μm long. Other long setae, some attaining a length of 240 μm , present on head and around margins of abdomen. Ventral setae numerous, of different sizes, but many are long, the longest about 200 μm . Minute setae present from about fifth segment as far forward as prothorax in a zone extending to spiracles. Body pores and tubular ducts absent.

Third Instar Female (Fig. 33)

Body ovoid, 1.15 mm long, tapering to last segment. Posterior end of body rounded, last segment sclerotized at least on dorsum, the ventral surface curved inwards to form a pair of lobes. Antennae with 4 segments, 1.10–1.23 mm long; on longest antenna, first segment 350 μm long, second 360 μm , third 180 μm and fourth 340 μm , narrower than other segments. Joint between first and second segments similar to that in adult female and with minute teeth on outer posterior angle of second segment fitting into small grooves on outer distal angle of first segment. Each segment with long slender setae of different lengths. Legs similar in shape to those in adult female but shorter, hind trochanter+femur 280–310 μm long, hind tibia+tarsus 350–400 μm long. Labium as in adult but 205 μm long and 88 μm wide, with 13 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae 12 μm long, 4 pairs of subapical setae set wide apart so that proximal pair at mid-point of segment, the setae ranging in length from 12 μm at apex to 68 μm on mid-segment. Also present 1 pair of lateral setae and 1 pair of anterior setae each 68 μm long. Medial segment with 1 pair of setae 60 μm long. Basal segment with each lobe containing 2 short setae each 8 μm long and 1 seta 36 μm long. One circulus present, circular, about 32 μm in diameter, situated in middle of fourth segment. Anal ring at apex of dorsal surface about 56 μm wide, with narrow sclerotized rim and surrounded by 4 pairs of setae. The anterior median pair are slender and only slightly longer than diameter of ring, outer 2 pairs stouter, the third pair about 210 μm long and the fourth pair 440 μm long. Anal lobes each with one dorsal and two ventral stout setae about 1.0 mm long, there being also a slender seta about 150 μm long on inner margin of lobe.

Dorsal setae abundant anterior to fourth abdominal segment, these mainly slender 12–16 μm long, the distance between setal bases usually shorter than length of one seta or about same length. Minute flat setae with varying distal shape, scattered among slender setae on prothorax and mesothorax. Dorsal setae on fourth and posterior segments fewer and of different sizes, the longest about 180 μm . Ventral setae mainly long and slender on abdomen, the longest about 160 μm but from first segment to prothorax small slender setae, similar to those on anterior dorsum extend inwards from margin to spiracles. Pores and tubular ducts absent.

First Instar (Fig. 34)

Body oval, 0.7–0.9 mm long, membranous except for anal lobe segment which on dorsum is sclerotized on margin extending to a band anterior to anal ring. Anal lobes present ventrally, these also sclerotized. Antennae with 4 segments similar in shape to those of previous stages, 0.85–0.90 mm long, the longest antenna with first segment 240 μm long, the second 320 μm , third 110 μm and fourth 230 μm long. Each segment with slender setae varying in length, the longest about 300 μm . Joint between first and second segments similar to those in other stages. Legs as in previous stages except that tarsus longer than tibia whereas in other stages the tibia is longer than tarsus. Hind trochanter+femur about 220 μm long, hind tibia+tarsus 240–260 μm long. Claw slender, 28 μm long. Labium 180 μm long and 80 μm wide with similar setal distribution to that in previous stages but setae longer than in third stage. Apical segment with a pair of apical setae each 8 μm long, 4 pairs of subapical setae extending to a point more than half length of segment and ranging in length from 12 μm distally to an inner pair 76 μm long. Also present are a lateral pair and an anterior pair each 76 μm long. Medial segment with either 1 or 2 pairs of setae, the longest 72 μm . Basal segment with a pair of setae each 8 μm long and 1 seta 72 μm long on each lobe. Circulus round, about 28 μm in diameter, situated within borders of fourth segment. Anal ring entirely on dorsum, with narrow rim and 4 pairs of setae around outer margin, there being 2 pairs of inner slender setae each about 60 μm long, a third stouter pair about 360 μm long and a stout posterior pair about 750 μm long. The last setae resemble anal lobe setae which are of similar shape and length, there being on each lobe, a pair on dorsal margins and a single seta at apex of lobe on venter.

Dorsal setae mainly short and slender on anterior abdominal segments, thorax and head, each about 12 μm long. A few flat and irregularly shaped setae present on prothorax each about 8 μm long. Abdominal setae all slender, of different lengths, the longest always in transverse rows, about 120 μm long.

Ventral setae on abdomen similar to those on dorsum of abdomen but fewer. Setae sparse on thorax and head. Pores and tubular ducts absent.

MATERIAL EXAMINED. *Xenococcus annandalei* Silvestri, lectotype ♀, INDIA: Barkuda I. (IEAUN, Portici).

INDIA: 7 ♀, same data as lectotype; 2 ♀, 1.x.1922 (IEAUN, Portici), 1 ♀ and 1 third stage ♀ (BMNH, London), 1 ♀ and 1 third stage ♀ (USNM, Washington); 8 ♀, on *Ficus religiosa*, 28.vi.1922 (*N. Annandale*) (7 ♀, on slides and in alcohol, IEAUN, Portici; 1 ♀, BMNH, London); Mysore, on coconut roots (Palmae), 21.vi.1937 (*T. V. Subramaniam*) (3 first stage, BMNH, London). MALAYSIA: Malaya, Penang, 1 ♀ (IEAUN, Portici). VIETNAM: 1 ♀, Than-hoa (IEAUN, Portici). HONG KONG: 1 ♀, Repulse Bay (IEAUN, Portici).

DISCUSSION. This is an unusual species that will probably be found underground throughout south-east Asia, attended by the ant *Acropyga acutiventris*. The peculiar antennae, with the unusual articulation between the first and second segments, are similar in all stages but as yet no second stage has been available.

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